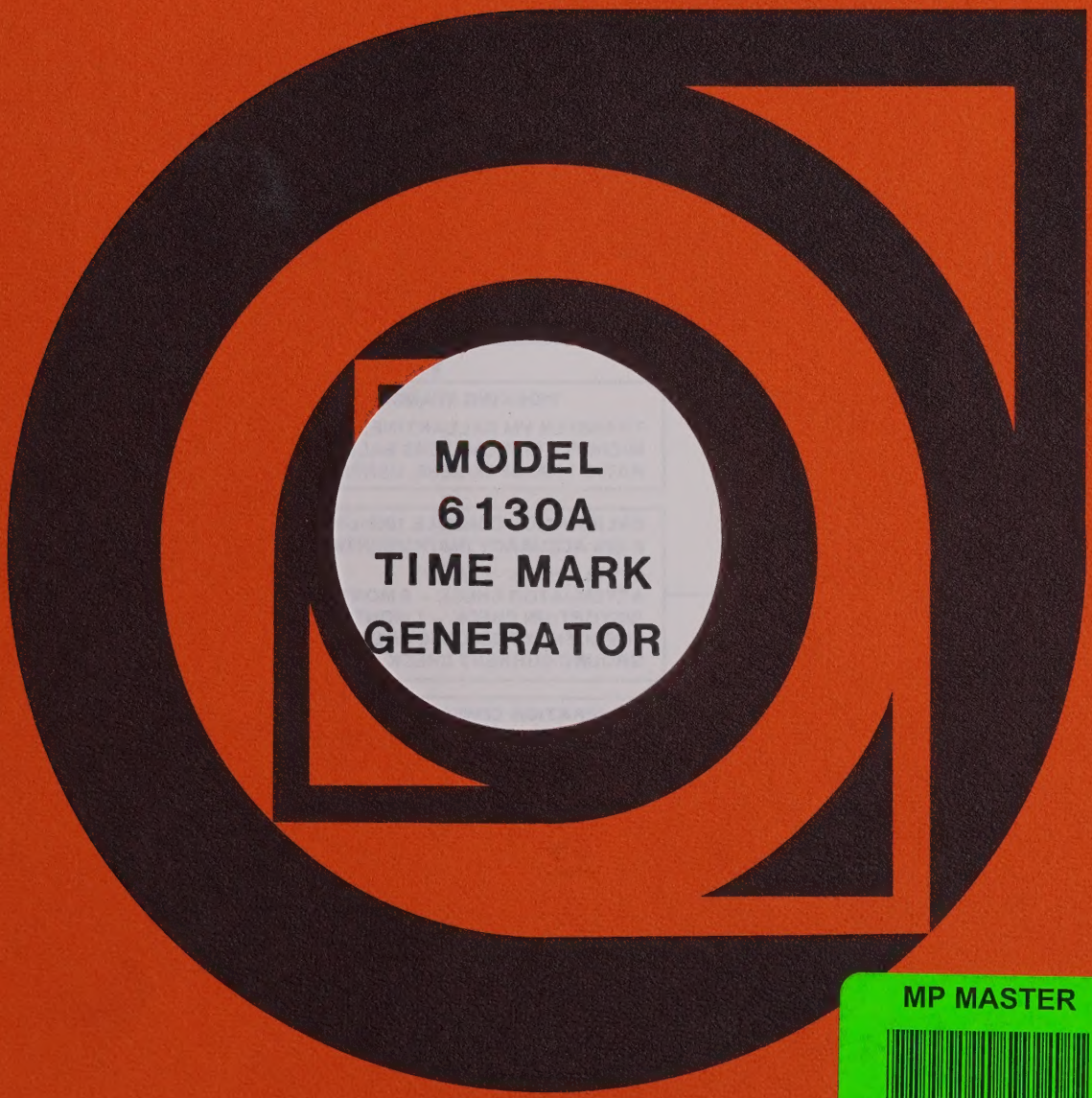
00265

Ballantine



MP MASTER
MA26086

INSTRUCTION MANUAL

MODEL 6130A TIME MARK GENERATOR

ALSO COVERS:

6130A MOD101 (AN/USM-441)

Ballantine Laboratories, Inc. • P.O. Box 97 • Boonton, New Jersey 07005 U.S.A.
Telephone: 201-335-0900 • TWX: 710-987-8380

90102955B

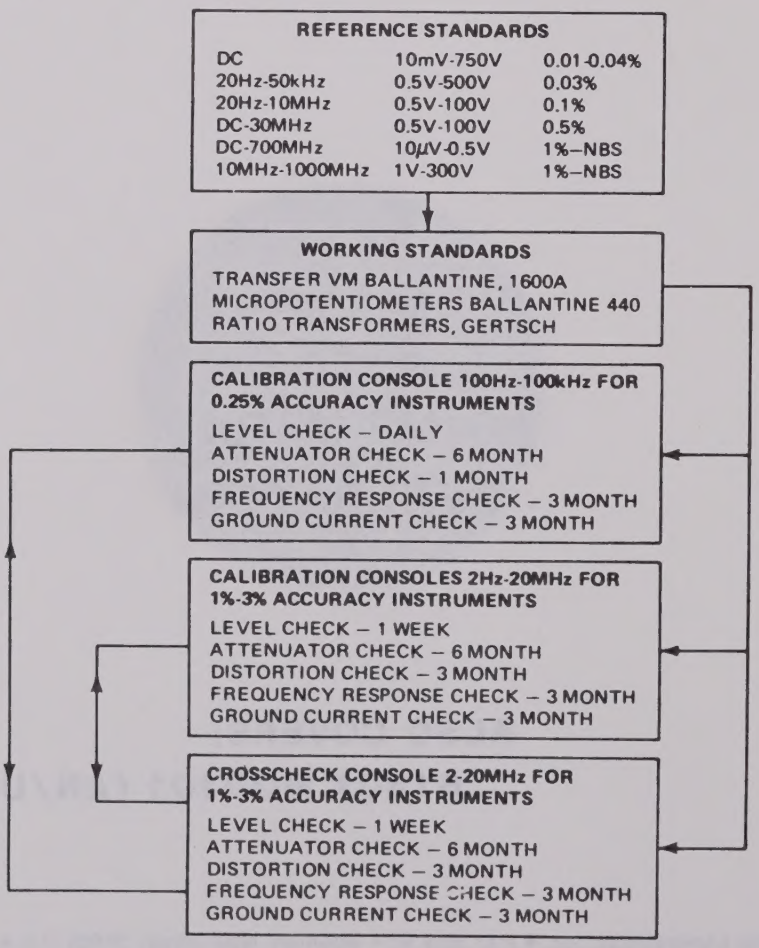
MAY 1984

WARRANTY

This Ballantine Laboratories, Inc. product is warranted against defects in materials and workmanship for a period of one year from the date of shipment, except for batteries, electron tubes, vacuum thermocouples, and certain other components, if any, listed in this manual. Ballantine Laboratories, Inc. will, at its option, repair or replace products which prove to be defective during the warranty period provided they are returned to Ballantine Laboratories, Inc. prepaid, and provided the proper preventive maintenance and calibration procedures as listed in this manual have been followed. Repairs necessitated by misuse of the product are not covered by this warranty. NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. BALLANTINE LABORATORIES, INC. IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

CERTIFICATION

Ballantine Laboratories, Inc. certifies that this equipment meets all applicable Ballantine specifications at time of shipment from the factory as determined by thorough testing and inspection. Ballantine further certifies that its measurements are traceable to the United States National Bureau of Standards. All instruments used in calibrating Ballantine products are standardized by systematic reference to NBS-traceable standards as described in the validation procedures shown below.


REFERENCE STANDARDS
DC 10mV-750V 0.01-0.04%
20Hz-50kHz 0.5V-500V 0.03%
20Hz-10MHz 0.5V-100V 0.1%
DC-30MHz 0.5V-100V 0.5%
DC-700MHz 10μV-0.5V 1%–NBS
10MHz-1000MHz 1V-300V 1%–NBS
WORKING STANDARDS
TRANSFER VM BALLANTINE, 1600A
MICROPOTENTIOMETERS BALLANTINE 440
RATIO TRANSFORMERS, GERTSCH
CALIBRATION CONSOLE 100Hz-100kHz FOR 0.25% ACCURACY INSTRUMENTS
LEVEL CHECK – DAILY
ATTENUATOR CHECK – 6 MONTH
DISTORTION CHECK – 1 MONTH
FREQUENCY RESPONSE CHECK – 3 MONTH
GROUND CURRENT CHECK – 3 MONTH
CALIBRATION CONSOLES 2Hz-20MHz FOR 1%-3% ACCURACY INSTRUMENTS
LEVEL CHECK – 1 WEEK
ATTENUATOR CHECK – 6 MONTH
DISTORTION CHECK – 3 MONTH
FREQUENCY RESPONSE CHECK – 3 MONTH
GROUND CURRENT CHECK – 3 MONTH
CROSSCHECK CONSOLE 2-20MHz FOR 1%-3% ACCURACY INSTRUMENTS
LEVEL CHECK – 1 WEEK
ATTENUATOR CHECK – 6 MONTH
DISTORTION CHECK – 3 MONTH
FREQUENCY RESPONSE CHECK – 3 MONTH
GROUND CURRENT CHECK – 3 MONTH

Ballantine's Quality Assurance program satisfied the requirements of MIL-I-45208

Ballantine

ADDENDUM

TO INSTRUCTION MANUAL:

MODEL No. 6130A
Applies to all units

Page 1-2. TECHNICAL SPECIFICATIONS

Change to read:

Trigger Risetime: < 3 ns into 50 ohms

WEIGHT: Net, 2.9 kg (6.4 lb). Shipping, 4.5 kg (10 lb).

Add:

1-19. OPTION 71 ELAPSED TIME INDICATOR. Adds an internally mounted elapsed time indicator, non-mercury type, to measure and display actual time that the equipment has been operating. Full scale reading of 5,000 hours.

TABLE OF CONTENTS

Section		Page
I	INTRODUCTION AND GENERAL INFORMATION	1-1
	1-1. Purpose of Manual	1-1
	1-3. Scope of Manual	1-1
	1-5. Purpose of Equipment	1-1
	1-7. Functional Description	1-1
	1-14. Accessories (Optional)	1-2
	1-16. Leading Particulars	1-2
II	SPECIAL TOOLS AND TEST EQUIPMENT	2-1
	2-1. Special Tools	2-1
	2-3. Test Equipment	2-1
III	PREPARATION FOR USE AND SHIPMENT	3-1
	3-1. General	3-1
	3-3. Unpacking and Initial Inspection	3-1
	3-5. Performance Checks	3-1
	3-7. Power Requirements	3-1
	3-10. Grounding Requirements	3-1
	3-13. Installation and Mounting	3-1
	3-18. Short-term Storage	3-3
	3-20. Long-term Storage or Repackaging for Shipment	3-3
IV	OPERATION INSTRUCTIONS	4-1
	4-1. Introduction	4-1
	4-3. Theory of Operation	4-1
	4-34. Operation Instructions	4-5
	4-36. Controls, Indicator, and Connectors	4-5
	4-38. Power Requirements	4-5
	4-41. Connections	4-9
	4-44. Turn-on Procedure	4-9
	4-45. Time Calibration of Oscilloscopes	4-9
	4-57. Calibration of Digital Counter-Timers	4-11
	4-59. Operation as a Frequency Divider	4-11
V	MAINTENANCE INSTRUCTIONS	5-1
	5-1. Introduction	5-1
	5-4. Test Equipment	5-1
	5-6. Performance Checks	5-1
	5-9. Oscillator Frequency Accuracy and Stability	5-1
	5-10. Marker Output	5-1
	5-11. Trigger Period	5-3
	5-12. Trigger Output Rise Time	5-5
	5-13. High Frequency Output	5-5
	5-14. External Clock Input	5-5
	5-15. Calibration and Alignment Procedures	5-7
	5-21. Clock Frequency Adjust (C302)	5-7
	5-22. 10-MHz Tuned Amplifier Adjust (C308)	5-7
	5-23. 50-ns H.F. OUT Adjust (L401, R403)	5-10
	5-24. Flatness Adjustment	5-10
	5-25. 10-ns H.F. OUT Adjust (C410, C414, C416, L403)	5-10
	5-26. 5-ns H.F. OUT Adjust (C421)	5-10
	5-27. 2-ns H.F. OUT Adjust (C426, C427, C428, C430, C431, C432, C434)	5-11
	5-28. Troubleshooting and Fault Finding	5-11
	5-30. Printed Wiring Board Repair and Cleaning	5-11
VI	DIAGRAMS	6-1
VII	ILLUSTRATED PARTS BREAKDOWN	7-1

LIST OF ILLUSTRATIONS

Number	Title	Page
1-1.	6130A-101 Time Mark Generator (Generator, Electronic Marker AN/USM-441)	1-3
3-1.	6130A-101 Time Mark Generator, Outline Dimensions	3-2
3-2.	6130A-101 Time Mark Generator, Rack Mounting Dimensions	3-2
3-3.	6130A-101 Time Mark Generator, Packing Diagram	3-4
4-1.	6130A-101 Time Mark Generator, Block Diagram	4-3
4-2.	6130A-101 Time Mark Generator, Operating Controls, Indicator, and Connectors	4-6
4-3.	Voltage Selecting and Fused Connector J5, Printed Circuit Board Location and Orientation	4-8
4-4.	Rise Time Display	4-10
5-1.	Performance Assurance Test Record Form	5-2
5-2.	Clock Frequency Check, Bench Test Setup	5-4
5-3.	Trigger and Marker Amplitude Check, Bench Test Setup	5-6
5-4.	Trigger Rise Time and H.F. OUT Check, Bench Test Setup	5-6
5-5.	External Clock Input Check, Bench Test Setup	5-8
5-6.	Internal Adjustments and Test Points	5-9
6-1.	6130A-101 Time Mark Generator, Schematic Diagram	6-1

LIST OF TABLES

Number	Title	Page
2-1.	Test Equipment	2-1
4-1.	Operating Controls, Indicator, and Connectors	4-7
5-1.	Troubleshooting Aids	5-12

SECTION I

INTRODUCTION AND GENERAL INFORMATION

1-1. PURPOSE OF MANUAL.

1-2. This technical manual contains operation and maintenance instructions for Model 6130A Time Mark Generator, manufactured by Ballantine Laboratories, Inc., Boonton, New Jersey. The Model 6130A MOD101 is also identified by the government assigned nomenclature as Generator, Electronic Marker, Type AN/USM-441. All information in this manual is applicable to either nomenclature, though only the part number 6130A may be used as a reference. The basic difference between the 6130A and the AN/USM-441 is that the latter has front panel protective handles and is tested to the Air Force approved Acceptance Test Procedures for compliance to MIL-T-28800B Type II, Class 4.

NOTE

Unless otherwise specified, the term "generator" as used in this manual is a common-name reference to either the 6130A or the AN/USM-441 (6130A MOD101).

1-3. SCOPE OF MANUAL.

1-4. Descriptive information, operational information, and testing and troubleshooting procedures, arranged as outlined in the table of contents, are included in this manual. Repair, replacement, and adjustment procedures are limited to those capable of being performed by organizational and intermediate-level activities using the tools, test equipment, and spare parts authorized in the allowable list. An illustrated parts breakdown is shown in Section 7 of this manual.

1-5. PURPOSE OF EQUIPMENT.

1-6. The 6130A Time Mark Generator, shown in Figure 1-1, is a portable, half-rack, solid-state, signal device which provides accurate frequency and time waveforms. It is used to calibrate the sweep-time accuracy of oscilloscopes, the gate-time performance of digital counters, and the frequency dispersion of spectrum analyzers; it is also used to check the frequency calibration of signal generators and oscillators. (A high-stability, ovenized oscillator, with drift rates of three parts in 10^9, is available as Option 14 if the generator is to be used as a secondary frequency standard.) Output signals include marker pulses with time intervals selectable between 100 ns and 5 s, high-frequency signals selectable between 2 ns and 50 ns, and trigger square waves with selectable repetition times between 100 ns and a 1 s. These output signals may also be derived from an external 10-MHz source.

1-7. FUNCTIONAL DESCRIPTION.

1-8. The primary system clock of the 6130A is a 10 MHz oscillator, which is controlled by a crystal housed in a fast warm-up oven. All output signals are derived from this source. A frequency-divider chain provides marker pulses at selectable time intervals of 100, 200, or 500 ns, or their decade submultiples down to 500 ms, controlled by a front-panel time/division (TIME/DIV) rotary switch. These marker pulses may be used directly (X1) or through a supplemental frequency divider which multiplies the time interval by X2, X5, or X10. The multiplication factor is controlled by a MULTIPLIER switch which extends the repetition-time range to 5 seconds. The marker pulses then pass through a shaping circuit which provides a sharp spike signal at the MARKER OUTPUT terminal for precise timing functions. The output amplitude is typically 1 volt into a 50-ohm termination or 2 volts into an open circuit.

1-9. The 10-MHz oscillator also feeds a frequency multiplier which provides high-frequency sinusoidal signals with 50-, 10-, 5-, or 2-ns repetition rates at the H.F. OUT terminal. The rate is selected by the HIGH FREQUENCY switch. The output is greater than 0.5 volt peak-to-peak into 50 ohms (1-volt open circuit).

1-10. Trigger output square waves at the TRIGGER OUT terminal are derived from the frequency divider through the TRIGGER PERIOD switch and a shaper which gives the pulses very-fast (3 ns or less) rise and fall times. Eight periods at decade multiples between 100 ns and 1 s are available at an amplitude greater than 0.5 volt peak-to-peak into 50 ohms (1-volt open circuit).

1-11. Option 14 provides a high-stability time base. The frequency is 10 MHz, and the oscillator and quartz crystal are temperature-controlled in a proportional oven. The frequency drift is less than 3 parts in 10^9 per day after 72 hours operation.

1-12. The rear panel includes a voltage selecting and fused input power connector, an internal-external clock selector switch, a connector for an external clock signal, if used, and an oscillator adjustment which is used for calibration.

1-13. The 6130A may be used as a portable bench instrument or it may be installed in one half of a standard 19-inch relay rack. For portability,

the instrument is fitted with a side-mounted, flexible carrying handle and two front-mounted, rigid bail handles. To facilitate installation in a relay rack, a relay-rack frame, Ballantine Model 800-06, and a half-rack cover plate, P/N 381000371, which is used to cover the unused portion of the rack, are available as options.

1-14. ACCESSORIES (OPTIONAL).

1-15. The following optional accessories are available for use with the 6130A.

Adapter, BNC to dual binding post, Ballantine Model 12622A

Termination, 50 ohms, 2 W, feed-through, BNC to BNC, Ballantine Model 12630A

Cable, 50-ohm, BNC to BNC male connectors, 4 feet long, Ballantine Model 12249D

Protective Carrying Case, padded vinyl with zipper closure, Ballantine Model 10755A

1-16. TECHNICAL SPECIFICATIONS.

1-17. The following leading particulars specify the electrical, physical, and environmental characteristics of the 6130A.

HF Sine Wave Periods: Four ranges, 2 ns (500 MHz), 5 ns (200 MHz), 10 ns (100 MHz), 50 ns (20 MHz).

HF Sine Wave Amplitude: > 0.5 volt into 50 ohms. 1 volt open circuit.

Marker Periods, Time/Division: 21 ranges. 1, 2, 5, sequence. 0.1 us to 0.5 s.

Marker Multiplier: Four steps. X1, X2, X5, X10. Extends range to 5 seconds.

Marker Amplitude: > 0.5 volt into 50 ohms. > 1 volt open circuit. Typically 1 volt into 50 ohms.

Marker Shape: 1 us to 5 s/division spike. Width at base typically 10% of pulse intervals. 0.1 us to 0.5 us pulse width; at base, typically 30% of pulse interval.

Trigger Period: 8 ranges, 0.1 us to 1 s in decade steps.

Trigger Rise Time: <3 us into 50 ohms.

Trigger Waveform: Fast-rise square wave coincident with the time marks. Negative-going from ground. Overshoot and preswing less than 2% on fast rise edge. Flatness of positive top of waveform ±0.5%.

Trigger Amplitude: > 0.5 volt into 50 ohms. > 1 volt open circuit.

Trigger Time Coincidence: In the Trigger Period Marker Lockout Mode, the trigger gates the marker so as to provide nominal time coincidence between marker and trigger for all conditions where the marker period is less than the trigger period.

Accuracy, Internal Clock: 10-MHz frequency period within 0.0008% (8 ppm) from 20° C to 30° C and within 0.0016% (16 ppm) from 0° C to 50° C.

Stability, Internal Clock: Within 3 ppm in 24 hours at 0.1 us (10 MHz) after 1.5 hours of operation (20° C to 30° C).

Clock Output: >250 mV peak to peak at 10 MHz. Available at rear panel BNC connector.

External Clock Input: >2 volts peak to peak sine wave and >3 volts below 35 kHz. >2 volts peak pulse amplitude at all frequencies to 1 MHz.

Maximum External Clock Input Amplitude: 5 volts (dc + peak ac).

Frequency, External Input: Continuous from 100 kHz or less to 10 MHz. Lower frequencies may be used if the rate of rise is faster than 0.08 V/us. HF sine wave outputs available only with 10 MHz input.

Input Impedance: 50 ohms ±5 ohms shunted by 20 pF.

Power Requirements: 100, 120, 220, or 240 volts rms, 50 to 400 Hz, 25 VA.

Operating Temperature: 0° C to +50° C.

Storage Temperature: -54° C to +85° C.

Relative Humidity: To 95% RH operating.

Shock and Vibration: Designed to meet MIL-T-28800, Type II, Class 4 requirements.

Altitude: 5 km operating (10,000 feet), 15 km storage (50,000 feet).

Dimensions: 133 mm high x 216 mm wide x 267 mm deep case and 300 mm deep overall (5.25 in. x 8.5 in. x 10.52 in. and 11.83 in.).

Weight: Net, 3.2 kg (7 lb). Shipping, 4.5 kg (10 lb).

1-18. OPTION 14 OSCILLATOR. The following specifications, in addition to those listed in paragraph 1-17, apply to the Option 14 oscillator.

Aging Rate (after warmup): $< \pm 3 \times 10^{-9}$/day after 72 hours.

Temperature Stability: $\pm 1 \times 10^{-8}$/°C (0° C to +50° C).

Short Term Stability: $\pm 5 \times 10^{-9}$ rms (for 10-second average).

Fast Warmup: Proportional oven-controlled crystal.

Line Voltage: $\pm 8 \times 10^{-10}$.

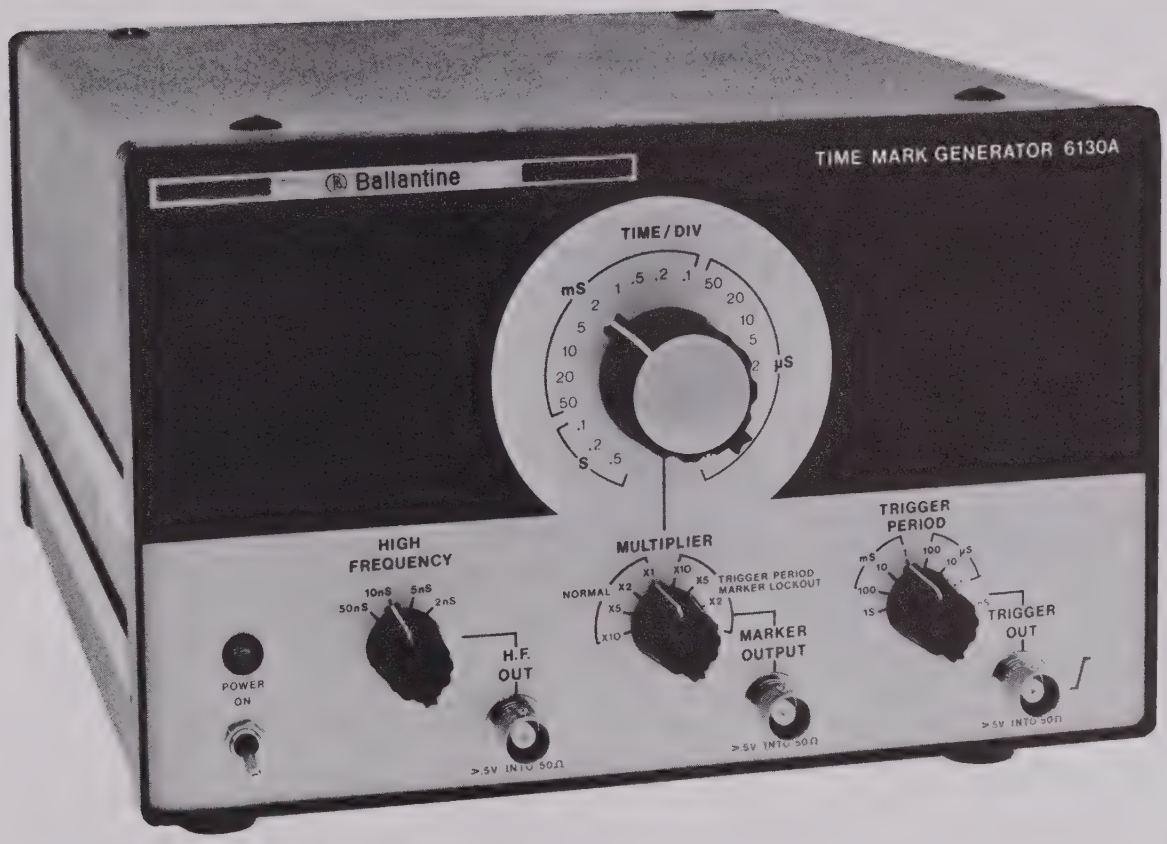


Figure 1-1. 6130A Time Mark Generator

SECTION II

SPECIAL TOOLS AND TEST EQUIPMENT

2-1. SPECIAL TOOLS.

2-2. No special tools are required for operation or maintenance of the 6130A Time Mark Generator.

2-3. TEST EQUIPMENT

2-4. Table 2-1 lists the test equipment required for maintenance of the 6130A Time Mark Generator. Equivalent test equipment may be substituted if the recommended test equipment is not available.

Table 2-1. Test Equipment

EQUIPMENT NO.	NOMENCLATURE	USE AND APPLICATION	MINIMUM SPECIFICATIONS
AN/USM-398 (Ballantine Model 1066S or 1022A)	Oscilloscope	General fault finding.	5 mV, dual trace. 8 x 10 cm graticule. DC to 15 MHz; rise time < 17 ns. Signal delay. Sweep time < 50 ns/cm to > 1 s/cm.
Ballantine Model 3028B	Multimeter	Fault finding; power supply supply and resistance checks.	DC, 1 mV to 1 kV. AC, 1 mV to 500 V, 10 Hz to 100 kHz rms responding. Ohms, 0.1 Ω to 20 MΩ, 0.2 V to 2 V measuring voltage. AC amperes, 100 mA to 1A. DC amperes, 100 mA to 1A. 3-1/2 digit display, battery and line operation.
Ballantine Model 3620A	AC/DC True RMS Digital Voltmeter	Line voltage measurement.	4-1/2 digit display. 10 mV to 1 kV full scale. 1 uV resolution. DC and ac to 1 MHz, dc coupled true rms response. Nominal accuracy 0.2%. Guarded and floating input.
Ballantine Model 5700A (with Option 14) or Model 9648M	Digital Frequency Counter	Frequency calibration and check of frequency multipliers 500 MHz (2 ns).	512-MHz nine-digit counter with high-stability clock (3 parts in 10^9 per day) and NBS frequency traceability. External clock input capability. Sensitivity better than 15 mV rms at 500 MHz.

Table 2-1. Test Equipment (Cont)

EQUIPMENT NO.	NOMENCLATURE	USE AND APPLICATION	MINIMUM SPECIFICATIONS
Ballantine Model 12620A	Adapter	Test equipment connections.	BNC female to General Radio GR-874 connector.
Ballantine Model 12625A	Adapter	Test equipment connections.	BNC male to General Radio GR-874 connector.
Ballantine Model 12630A	Termination	Termination, 50 ohms, 2 watts.	BNC/BNC feedthrough, 50 ohms, 2 watts.
Ballantine Model 12249A	Cable Assembly, 8 in.	Test equipment connections.	RG-58C/U cable with male BNC terminations.
Ballantine Model 12249D	Cable Assembly, 48 in.	Test equipment connections.	RG-58C/U cable with male BNC terminations.
General Radio Type GR-874 (Ballantine Model 12626A)	Attenuator, 20 dB	Input attenuator for high-sensitivity sampling oscilloscope.	50-ohm, 20-dB attenuator, dc to 1 GHz, flatness 0.1%, dc to 100 MHz.
General Radio Type W5MT3A	Metered Variac	Line voltage control; metered current and voltage.	(As required.)
Hewlett-Packard Model 651B or 652A	Test Oscillator	Test external clock input signal source.	10 Hz to 10 MHz (sine wave). 50-ohm output to 2 V rms. Distortion < ±0.25%.
JFD Part No. 5284	Adjustment Tool	Adjustment of variable capacitors, resistors, and inductors.	Low-capacity alignment tool with 3/32 inch screwdriver blade and 5/64 hexagon drive.
Rohde & Schwarz Model XSAM or Model XSA/XKA*	Frequency Standard, Atomic or WWV Receiver	To calibrate clock frequency.	Rubidium frequency standard, 1 MHz, or WWV receiver/comparator, 1 MHz.
Tektronix Type 547 (with 1S1 plug-in)	Oscilloscope	Check fast rise time (≤ 3 ns) of TRIGGER output square wave.	Frequency response to 1 GHz. Rise time < 0.35 ns. Internal and external triggering beyond 500 MHz. 50-ohm input. Sensitivity better than 50 mV/cm. Sweep time < 2 ns/cm to 0.1 us/cm.
UG-274A/U (Ballantine Model 12619A)	Adapter	Test equipment connections.	BNC tee adapter.

*Optional

SECTION III

PREPARATION FOR USE AND SHIPMENT

3-1. GENERAL.

3-2. This section contains information and instructions necessary for the installation and reshipment of the 6130A Time Mark Generator. Details are provided for initial inspection, performance checks, power connections, grounding safety requirements, installation information, and repacking instructions for storage or shipment.

3-3. UNPACKING AND INITIAL INSPECTION.

3-4. Unpacking and initial inspection of the generator require only the normal precautions and procedures applicable to the handling of sensitive electronic equipment. The contents of all shipping containers should be checked for included accessories and certified against the packing slip to ascertain that the shipment is complete.

3-5. PERFORMANCE CHECKS.

3-6. This instrument was carefully inspected for mechanical and electrical performance before shipment from the factory. It should be free of physical defects and in acceptable operating condition upon receipt. Check the instrument for possible damage incurred while in transmit. Complete the performance checks beginning with paragraph 5-6. If there is any indication of damage or improper operation, refer to the warranty included in this manual, and notify the manufacturer or the manufacturer's field representative.

3-7. POWER REQUIREMENTS.

3-8. The generator may be operated from an ac voltage source rated at 100, 120, 220, or 240 volts rms at 50 to 400 Hz. The orientation of the printed circuit board in the ac power connector on the rear of the instrument matches the instrument to the ac voltage source.

CAUTION

Failure to orient the printed circuit board properly will damage the instrument and void the warranty.

3-9. The instrument should be operated from a power source with its neutral at or near ground (earth) potential. The instrument is not intended for operation from two phases of a multiphase ac system or across the legs of a single-phase, three-wire ac power system. Crest factor (ratio of peak voltage to rms) should be typically within the range of 1.3 to 1.6 at ±10% of the nominal line voltage. Use a true rms responding voltmeter, such as the Ballantine Model 3620A, to measure the power line voltage.

3-10. GROUNDING REQUIREMENTS.

3-11. To insure the safety of operating personnel, the U.S. Occupational Safety and Health Act (OSHA) and good engineering practice require that the instrument panel and enclosure be "earth" grounded. All Ballantine instruments are provided with a three-conductor power cable assembly which, when plugged into an appropriate power receptacle, grounds the instrument. The offset pin on the male end of the power cable is the ground wire connection to the connector on the rear panel of the instrument.

3-12. To preserve the safety protection feature, when operating the instrument from a two-contact power outlet, use a three-prong to two-prong adapter and connect the green lead or terminal on the adapter to "earth" ground.

WARNING

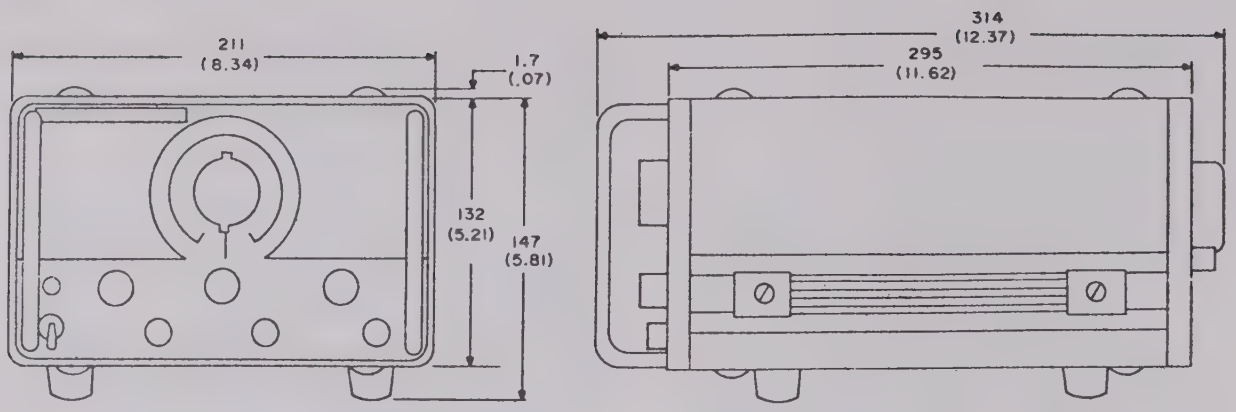
When using an external dc power source, or with internal battery operation, there is no ground return through the power cord. Take care to avoid electrical shock; also, consider connecting the instrument cabinet to earth ground through J8, the rear-panel, ground binding post.

3-13. INSTALLATION AND MOUNTING.

3-14. GENERAL. The generator is fully solid state and dissipates minimal heat. No special cooling is required; however, the instrument should not be operated where the ambient temperature exceeds 55°C (131° F) or when condensation due to high humidity appears anywhere on the instrument.

3-15. BENCH MOUNTING. The generator is shipped with plastic bumper-feet and a metal tilt-stand in place, ready for use as a bench instrument. Outline dimensions are shown in Figure 3-1.

3-16. RACK MOUNTING. The generator may be rack-mounted in a standard 19-inch EIA rack. The instrument is a half-rack configuration and one or two instruments may be rack-mounted in Rack Mount 800-06, which is available as an accessory. Mounting dimensions are shown in Figure 3-2. If only one unit is to be mounted in the rack, a cover plate, Ballantine P/N 381000371, is required to cover the other half of the rack. Before installing



NOTE: DIMENSIONS ARE IN MILLIMETERS AND (INCHES).

Figure 3-1. 6130A and 6130A MOD101 Time Mark Generator, Outline Dimensions

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETERS AND (INCHES).
2. WHEN ONLY ONE INSTRUMENT IS MOUNTED, A HALF-RACK COVER, BALLANTINE PART NUMBER 38100371, IS REQUIRED TO COVER THE RIGHT OPENING.

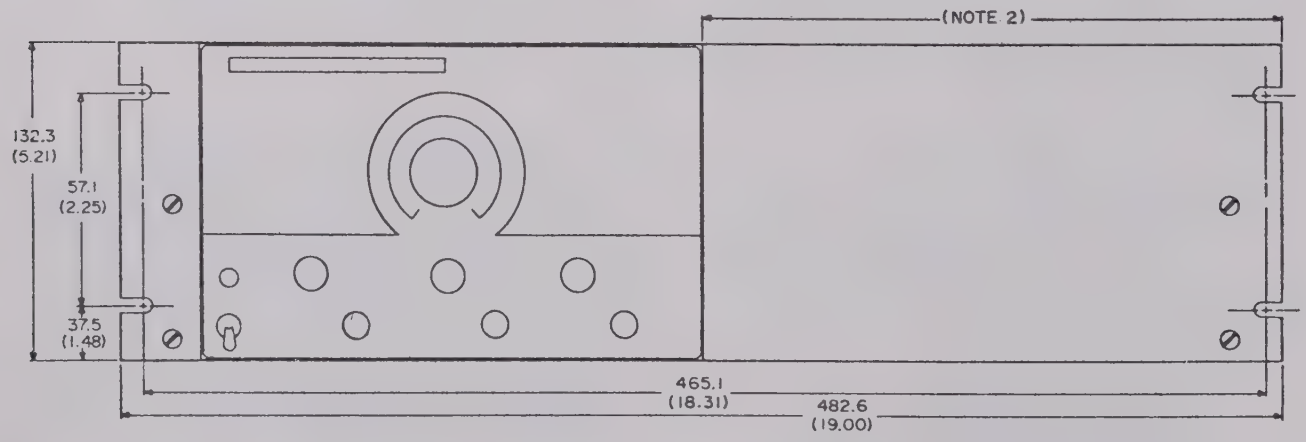


Figure 3-2. 6130A Time Mark Generator, Rack Mounting Dimensions

the instrument in the rack, remove the side carry handle, and from the bottom, remove the plastic bumper-feet and the tilt stand. Do not discard these items, but store them for future use. Unlock the four quarter-turn, plastic, button-head screws on the bottom cover and remove the bottom cover. Secure the bottom cover to the rack-mount shelf with the four 4-40 flat head screws, flat washers, lock washers, and nuts supplied with the rack mount. Reinstall the instrument on the secured bottom cover and attach the unit to the bottom cover by rotating the four plastic, quarter-turn screws on the bottom of the cover to engage the inside pawls.

3-17. PORTABLE USE. The instrument as supplied includes a side carry-handle (Option 16) and two front bail handles. A vinyl protective carrying case with zipper closure (Ballantine Model 10755A) is also available as an option.

3-18. SHORT TERM STORAGE.

3-19. If the instrument is to be stored for a short period of time (less than three months), place cardboard over the panel and cover the instrument with a suitable protective covering, such as a plastic bag or strong, kraft paper. Place power cable and other accessories with the instrument. Store the covered instrument in a clean, dry area that is not subject to extreme temperature variations or conditions which may cause moisture to condense on the instrument.

3-20. LONG TERM STORAGE OR REPACKAGING FOR SHIPMENT.

3-21. If the instrument is to be stored for a period longer than three months, or if it is to be repackaged for shipment, as a general guide, repackage the instrument as described in the following procedure and shown in Figure 3-3. Use either the original packing material, if available, or material similar to that specified. Proceed as follows:

a. Place the instrument accessories, if any, in a plastic bag and seal the bag.

b. For long distance shipping only, use U.S. Government packaging method IIC and tape a two-unit bag of dessicant (MIL-D-3464) on the rear cover.

c. Place a piece of sturdy cardboard over the front panel for protection. Enclose the instrument in a plastic bag and seal the bag.

d. Wrap the bagged instrument and accessories in a 1-inch thick, flexible, cellular plastic-film, cushioning material (PPP-B-795) and place in a barrier bag (MIL-B-131). Extract the air from the bag and heat seal.

e. Place the wrapped instrument and accessories into a fiberboard box (PPP-B-636) of suitable size. Fill spaces with rubberized hair or cellular plastic cushioning material. Close the box in accordance with container specifications. Seal with sturdy, water-resistant tape or with metal straps.

f. Mark container "FRAGILE," "HANDLE WITH CARE," or similar precautionary notice. Affix shipping labels as required or mark in accordance with MIL-STD-129.

NOTE

If the instrument is to be returned to Ballantine Laboratories, Inc. for calibration or repair, attach a tag to the instrument identifying the owner; also, note the problem, symptoms, and service or repair desired. List the model and serial number of the instrument. Ship the instrument prepaid to Ballantine Laboratories, Inc., 90 Fanny Road, Boonton, New Jersey 07005, U.S.A. In any correspondence, identify the instrument by model number, serial number, work authorization order, and date and method of shipment.

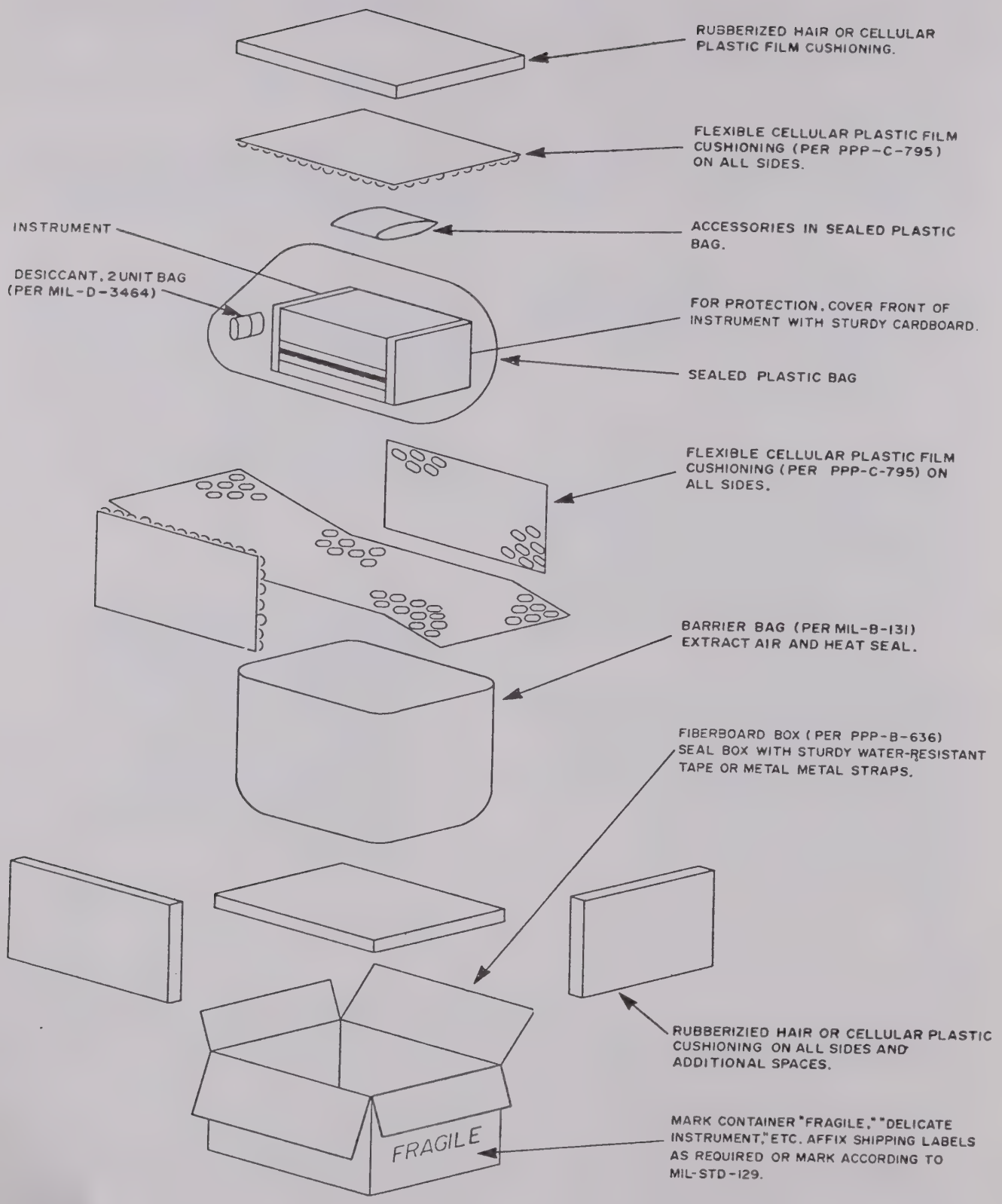

RUBBERIZED HAIR OR CELLULAR PLASTIC FILM CUSHIONING.
FLEXIBLE CELLULAR PLASTIC FILM CUSHIONING (PER PPP-C-795) ON ALL SIDES.
INSTRUMENT
DESICCANT, 2 UNIT BAG (PER MIL-D-3464)
ACCESSORIES IN SEALED PLASTIC BAG.
FOR PROTECTION, COVER FRONT OF INSTRUMENT WITH STURDY CARDBOARD.
SEALED PLASTIC BAG
FLEXIBLE CELLULAR PLASTIC FILM CUSHIONING (PER PPP-C-795) ON ALL SIDES.
BARRIER BAG (PER MIL-B-131) EXTRACT AIR AND HEAT SEAL.
FIBERBOARD BOX (PER PPP-B-636) SEAL BOX WITH STURDY WATER-RESISTANT TAPE OR METAL METAL STRAPS.
RUBBERIZIED HAIR OR CELLULAR PLASTIC CUSHIONING ON ALL SIDES AND ADDITIONAL SPACES.
FRAGILE
MARK CONTAINER "FRAGILE," "DELICATE INSTRUMENT," ETC. AFFIX SHIPPING LABELS AS REQUIRED OR MARK ACCORDING TO MIL-STD-129.

Figure 3-3. 6130A Time Mark Generator, Packing Diagram

SECTION IV

THEORY OF OPERATION AND OPERATING INSTRUCTIONS

4-1. INTRODUCTION.

4-2. This section discusses briefly the theory of operation of the 6130A and contains the operation instructions, including preliminary adjustments, alignment, if any, and minor maintenance. Detailed test procedures, alignment, and troubleshooting procedures are included in Section V.

4-3. THEORY OF OPERATION.

4-4. General. The 6130A Time Mark Generator is a solid-state precision calibrator consisting of the following major circuits:

a. A precision crystal-controlled 10 MHz clock oscillator.

b. A frequency doubler to 20 MHz (50 ns) and multipliers for 10-ns, 5-ns, and 2-ns sinewave marker intervals.

c. Integrated digital counting circuits which divide the 10-MHz clock in a $\div 2$ and $\div 5$ sequence to obtain 21 periods from 0.1 us to 0.5 s.

d. A digital divider of $\div 1$, $\div 2$, $\div 5$, and $\div 10$ which is used to further divide each TIME/DIV step and extend the division to 5-second periods.

e. A marker/output amplifier to buffer and shape the TIME/DIV marker output signals.

f. Decade step selection in the digital divider circuit chain to provide eight TRIGGER PERIODS from 100 ns to 1 s. These TRIGGER PERIODS are coincident with the time markers.

g. A high-speed shaping amplifier and buffer which operate on the TRIGGER PERIOD to provide a 3-ns rise time, flat-top square wave for aligning oscilloscope amplifiers.

h. Power supplies using full-wave rectifiers and monolithic integrated power regulators to provide the +5 volt and -12 volt internal dc power supplies.

4-5. BLOCK DIAGRAM. A simplified block diagram of the instrument is shown in Figure 4-1, and a schematic diagram is shown in Figure 6-1. The following paragraphs briefly discuss the theory of operation of the instrument with reference to this block diagram and the schematic diagram.

4-6. 10-MHz CLOCK OSCILLATOR. The 10 MHz-oscillator uses a three-section, monolithic, operational amplifier, U301. The amplifiers are connected in a high-gain, positive-feedback configuration which provides excellent long-term and short-term stability. Timing to exactly 10 MHz is accomplished by adjusting C302.

4-7. The quartz crystal, Y1, is hermetically sealed in a TO-5 shielded container which, in turn, is housed in a solid-state proportional oven. This oven quickly brings the crystal to its nominal ambient temperature of 65° C within 5 minutes after turn-on; stability is achieved within 1 or 2 hours. The heating element is a semiconductor resistor which rapidly increases resistance at its normal operating temperature to provide close temperature control.

4-8. Q301 and Q302 form a differential buffer amplifier which provides a 10-MHz internal clock signal to the internal time multiplier and for external use to a clock selector switch, S301, and a BNC connector, J4. Both the selector switch and connector are located on the rear panel. In the EXT CLOCK IN position, external clock signals connected to J4 can be used. In the INT 10 MHz CLOCK OUT position, the time multiplier is connected to an internal clock signal and a 10-MHz output signal is available at J4.

4-9. Q303 is both a buffer amplifier and an emitter follower for either the internal 10-MHz oscillator or the external clock input. Q304 is an emitter follower which provides low-impedance drive for the timing clock signal to the time multiplier, the high-frequency circuits, and the TRIGGER output circuit.

4-10. OPTION 14, PROPORTIONAL OVEN CLOCK. Option 14 provides a high-stability clock with a drift rate of three parts in 10^9 per day. Full specifications are listed in paragraph 1-18. When Option 14 is installed, Y1, the 10-MHz quartz crystal, and the associated components are omitted. The ovenized oscillator is supplied in a hermetically sealed enclosure which is mounted on a separate printed-wiring assembly board. In addition, R64, a 20-turn, electrical, fine-frequency adjustment is provided on the rear panel to permit tuning the precision oscillator to WWV or an external frequency standard. U61 is a monolithic, 15-volt regulator which provides a separate precision power supply for the oscillator and the oven.

4-11. To calibrate the oscillator frequency, first turn the instrument on and allow it to warm up for a continuous period of 72 to 96 hours. Then, using a cesium beam standard or WWV comparator as the certified precision source, perform the calibration procedure of paragraph 5-21. Use R64 to make the frequency adjustment. The drift rate of the oscillator should be checked over at least 1000 seconds

to be sure that the oscillator is exactly on frequency (within ±3 parts in 10^9).

4-12. Option 14 is fully compatible with all performance specifications of the instrument. A schematic diagram of the circuit is shown as part of Figure 6-1. The oscillator, P/N 89-10133-1A, is not a field-repairable part; if required, a replacement unit is available from Ballantine Laboratories. The oscillator is a premium component and its frequency adjustment range should provide from 3 to 5 years of use.

4-13. HIGH-FREQUENCY MULTIPLIERS.

4-14. General. The high-frequency multipliers are the 10-MHz oscillator for the signal input. The frequency is doubled to 20 MHz and quintupled to 100 MHz. The HIGH FREQUENCY switch, S11, on the front panel controls the frequency multiplication to further double the frequency to 200 MHz or to further quintuple the frequency to 500 MHz. S11 also controls the selection of the output time intervals of 50, 10, 5, and 2 nanoseconds available at the H.F. OUT connector, J1.

4-15. 10-MHz Tuned Amplifier. Q305 is a tuned buffer amplifier. A parallel resonant tank circuit in the collector of Q305 is tuned to 10 MHz to filter out unwanted harmonics and noise which might otherwise cause distortion and instability in the multipliers.

4-16. 20-MHz Frequency Doubler. The first frequency multiplier doubles the 10-MHz signal to 20 MHz. It consists of Q400 and Q401 which are driven push-push by a balanced drive from T400, which has a center-tapped secondary winding. The output of the 20-MHz doubler is tuned to 20 MHz by L401. R403 is adjusted to obtain maximum output and balanced drive for Q400 and Q401. Balancing the drive ensures minimum distortion and feed-through of the 10 MHz input drive.

4-17. 100-MHz Frequency Quintupler. The second frequency multiplier takes its 20-MHz input from T401 and quintuples it to obtain a 100-MHz output. Q402 and Q403 are driven in phase opposition from the center-tapped winding of T401. These transistors are connected push-pull to drive T402 which has a center-tapped primary tuned by C410 and C414 to ensure a clean 100-MHz output. The secondary of T402 forms a series-resonant circuit with C416 to provide a low-impedance drive at 100 MHz to the base of Q404 and to help suppress subharmonics of 100 MHz. The collector load of Q404 is tuned to 100 MHz with L403 and provides the 100-MHz output through the capacitive divider C418 and C419.

4-18. The HIGH FREQUENCY selector switch, S11, distributes the 100-MHz signal to the H.F. OUT connector, J1, or to the 200-MHz (5 ns) multiplier, or to the 500-MHz (2 ns) quintupler. S11 also selects the appropriate output frequency on any of its four positions and connects it to J1. The minimum number of multipliers are made active to minimize intermodulation distortion.

4-19. 200-MHz Frequency Doubler. The 200-MHz (5 ns) multiplier is a doubler. Q405 and Q406 are connected as a common collector push-push with their base input signal derived from the center-tapped secondary of T403. The collector load is T404 which resonates with the series-connected capacitive divider C421 and C422. The output of this frequency doubler is tuned to 200 MHz by C421.

4-20. 500-MHz Frequency Quintupler. The 500-MHz (2 ns) quintupler takes the 100-MHz signal to generate the 500-MHz output marker. Series-tuned L404 and C426 are tuned to 100 MHz to form the input circuit and couple the 100-MHz drive to CR401, the harmonic generator. CR401 is a varactor diode and generates harmonics of the 100-MHz drive. The second harmonic of 100 MHz is filtered out by a series-resonant trap, L405 and C427, which is tuned to 200 MHz. The third harmonic is filtered out by another series-resonant trap, L406 and C428, which is tuned to 300 MHz. The fifth harmonic of 100 MHz is applied to the base of Q407 through a series-resonant circuit consisting of L407 and C430, which is tuned to 500 MHz. The collector load of Q407 is tuned to 500 MHz by a printed circuit stripline filter, which is tuned by C434. Distortion in the 500-MHz output is minimized by the proper adjustment of capacitors C431 and C432.

4-21. 0.1-MICROSECOND TO 5-SECOND DIGITAL DIVIDERS. Integrated circuit digital dividers are used to divide the 10-MHz (0.1 us) clock into the desired MARKER OUTPUT periods. The dividers for each decade are identical ÷2 and ÷5 digital dividers. Type D flip-flops (binaries) using standard 7400 Series TTL logic are employed throughout. The divider chain is connected as a ripple counter.

4-22. The 10-MHz clock is applied to the input of U10 which divides the 0.1-us clock period by five to obtain the 0.5-us period. The next six divider stages (U11, U12, U13, U14, U15, and U16) each divide by two and five to provide outputs of 1 us, 5 us, 10 us, and 50 us, down to 0.5 second.

4-23. The TIME/DIV switch, S10, selects the appropriate output period. It also inserts the ÷2 section of U10 to obtain a full 1, 2, 5, 10 output sequence. Inserting the ÷2 circuit when required avoids disturbing the decade divider relationship of the count-down chain so that it may also supply the decade signals to the TRIGGER PERIOD circuit. The front of S10D selects the 1, 5, 10 sequence. The rear of S10D inserts the ÷2 circuit of U10. S10C connects either the direct signal from the front of S10D or the ÷2 output from U10. The output from S10C provides the output period selected by the TIME/DIV switch.

4-24. TIME MARKER MULTIPLIER. The time marker multiplier consists of a supplemental digital divider, controlled by the MULTIPLIER switch, S12, and an output clipper and buffer. When the TIME/DIV switch setting coincides with the setting of the time base switch of an oscilloscope under test, the

number of divisions between markers displayed on the oscilloscope is selected by the MULTIPLIER switch. Four positions, X1, X2, X5, and X10, are provided. These positions also extend the 0.5-second range on the TIME/DIV switch to 5 seconds.

4-25. U100 is a combined $\div 2$ and $\div 5$ digital IC. MULTIPLIER switch S12 selects one of the four division ratios and applies the output to the input of the output clipper and buffer amplifier. In the X1 position, the signal from the TIME/DIV switch is passed along directly without division. The X2 and X5 positions respectively insert the $\div 2$ and the $\div 5$ circuits. In the X10 position, the $\div 2$ and $\div 5$ circuits of U100 are connected in series.

4-26. The output signal from MULTIPLIER switch S12 is fed to the base of clipper amplifier Q100. The signal is "cleaned up" by Q100, which is driven hard into saturation and cutoff. Series resistor R100 acts to limit the base current in Q100. The collector of Q100 is series-peaked by L100 to shape the markers above 1 us and to maintain a reasonably constant output amplitude.

4-27. The output from the collector is differentiated by capacitors C10 through C21, which are selected by S10A and S10B. Varying the differentiating time constant maintains control of the MARKER OUTPUT pulse width. The differentiating resistors R104 and R105 serve to limit the current in CR100, which selects only positive-going marker pulses and rejects the negative-going differentiated pulses.

4-28. CR101 and CR102 raise the voltage at the base of Q101 so that it is always on the verge of conducting when no positive-going pulses are present. Q101 is an emitter follower and acts as an impedance-converting output buffer amplified to drive a coaxial cable. R108 provides source-termination matching for a 50-ohm cable.

4-29. TRIGGER PERIOD CIRCUITS. TRIGGER PERIOD switch S13 selects one of eight periods from 0.1 us to 1 s derived from the digital divider chain (refer to paragraph 4-21) and the digital frequency divider IC, U17, which extends the 0.5-second period to 1 second by series inclusion of its $\div 2$ circuit. All waveforms for the TRIGGER PERIOD circuits are square waves; that is, the high and low portions of the wave are of equal duration.

4-30. TRIGGER PERIOD MARKER LOCKOUT. MULTIPLIER switch S12 will select NORMAL OPERATION which directly steers the TRIGGER PERIOD square wave to the TRIGGER OUT connector or TRIGGER PERIOD MARKER LOCKOUT which steers the TRIGGER square wave through U18. U18 is a bistable multivibrator triggered by the presence of both the TRIGGER and the MARKER signal. The output of U18 becomes the TRIGGER OUTPUT whenever the selected TRIGGER PERIOD is longer in time than the selected MARKER OUTPUT and the MARKER and TRIGGER OUTPUTS will then be virtually time coincident.

4-31. Q200 and Q201 act as inverters which "slice" a section of the input square wave and provide sufficient speed to drive Q202. The network connecting Q200 and Q201 provides improved turn-off drive to Q201 and also slows the negative edge of the trigger period output square wave.

Q202 is an emitter follower which drives the emitter of common base amplifier Q203. In turn, Q203 drives the emitter of Q204 which is also connected in common-base configuration. R210 is the collector damping resistor. R209 and C203 provide additional isolation of noise and perturbations to optimize the TRIGGER OUT waveshape.

4-32. Q204 is fed at its emitter to provide maximum isolation of unwanted signals and minimize waveshape perturbations in the fast-rise output. The fast-rise, positive-going edge, which is usedto calibrate oscilloscope amplifiers, is produced as Q204 turns off. The top of the square wave output is therefore free from droop and tilt. Overshoot in the output waveform, resulting from stray inductance and stray base-emitted capacitance, is prevented by resistors R217 and R218 in the collector circuit. These provide damping beyond the critical point. The calibrating rise time is faster than 3 ns and is typically 1.8 ns into a 50-ohm system.

4-33. POWER SUPPLY. The power supply of the generator consists of two full-wave bridge rectifiers driven by transformer T1. The transformer has a multitapped primary which permits operation from nominal line voltages of 100, 120, 220, and 240 volts ac in compliance with world-wide IEC standards. The orientation of the printed circuit board in the fused ac input power connector is used to connect the transformer windings to match the ac power rating, as explained in paragraphs 2-39 and 2-40. Bridge rectifier CR1 and filter capacitor C1 supply unregulated dc to the +5 volt regulator IC, U1. Bridge rectifier CR2 and filter capacitors C3 and C4 supply unregulated dc to the -12 volt regulator IC, U2.

4-34. OPERATING INSTRUCTIONS.

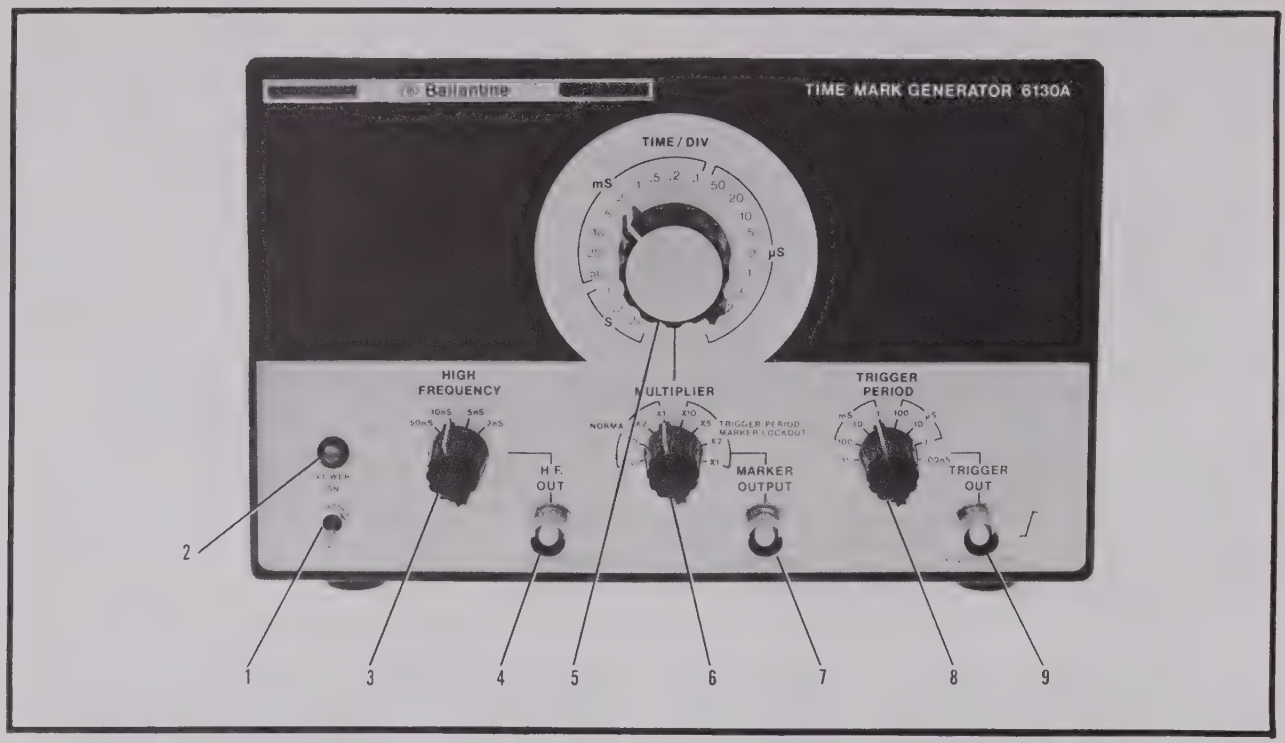
4-35. Paragraphs 4-36 through 4-62 contain instructions and information required for the operation of the 6130A Time Mark Generator.

4-36. CONTROLS, INDICATOR, AND CONNECTORS.

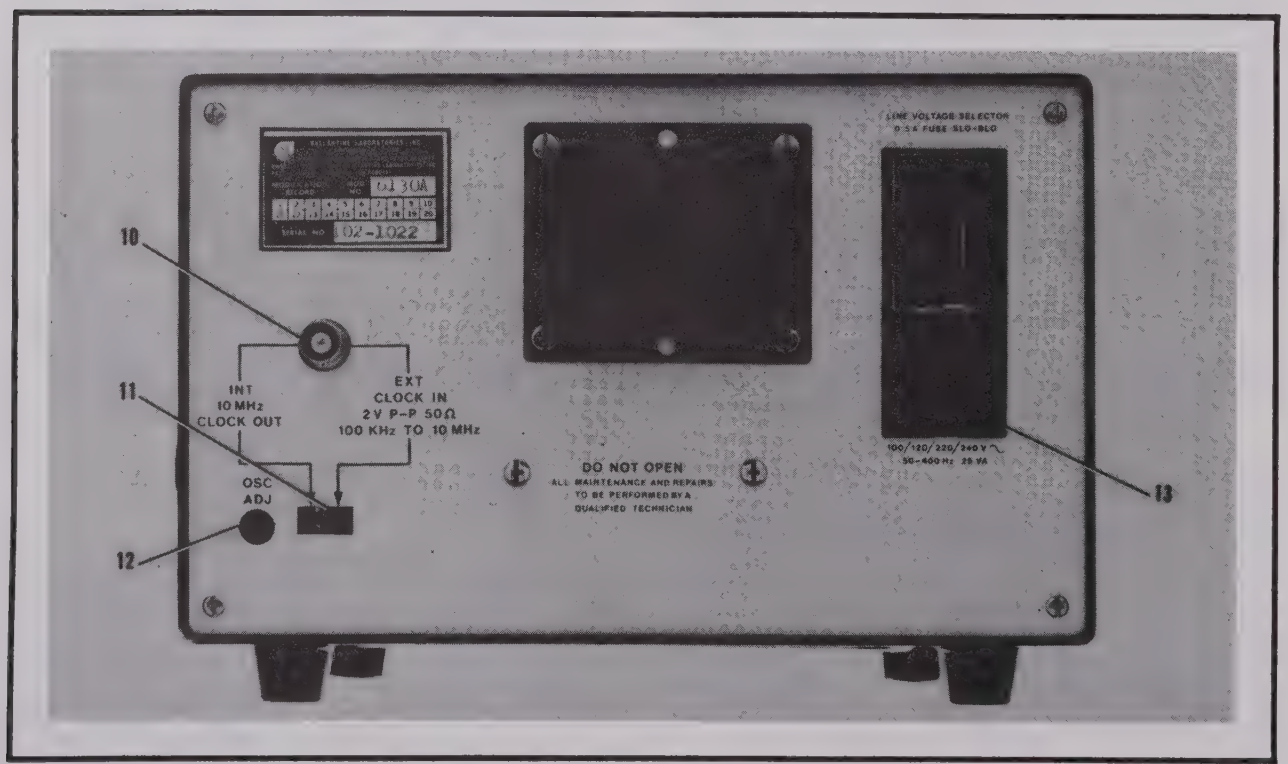
4-37. The operating controls, indicator, and connectors, located on the front and rear panels of the generator are shown in Figure 4-2, and their functions are described in Table 4-1.

4-38. POWER REQUIREMENTS.

4-39. GENERAL. The generator as supplied, is set to operate from a nominal 120-volt ac power source. However, the transformer used in the 6130A has an IEC multi-tap primary winding and a switching device is provided in J5 which permits operation from other standard ac power sources without any wiring modification. The voltage selecting and fused connector, J5, located on the rear panel, includes a printed-circuit board which can be removed and oriented to any one of four positions so as to connect the transformer primary for the operating voltage in use. With the proper orientation (refer to paragraph 4-40), the generator may be used within the range specified.



FRONT PANEL



REAR PANEL

Figure 4-2. 6130A Time Mark Generator, Operating Controls, Indicator, and Connectors

Table 4-1. Controls, Indicator, and Connectors

INDEX NO.	CONTROL, INDICATOR, OR CONNECTOR	REF DESIG	FUNCTION
1	POWER ON Switch	S2	Turns generator on or off.
2	POWER ON Indicator	DS1	Lights when generator is turned on.
3	HIGH FREQUENCY Switch	S11	Selects one of four high-frequency sine-wave outputs from 2 ns to 50 ns.
4	H.F. OUT Connector	J1	BNC output for high-frequency sine-wave markers.
5	TIME/DIV Switch	S10	Selects one of 21 marker outputs from 0.1 us to 0.5 s.
6	MULTIPLIER Switch	S12	Selects one of four TIME/DIV Marker multipliers from X1 to X10 and permits selection of TRIGGER PERIOD MARKER Lockout for Trigger/Marker synchronization.
7	MARKER OUTPUT Connector	J2	BNC output for markers.
8	TRIGGER PERIOD Switch	S13	Selects one of eight trigger periods from 0.1 us to 1 s.
9	TRIGGER OUT Connector	J3	BNC output for trigger periods.
10	INT-EXT Clock Connector	J4	BNC connector for internal 10-MHz clock output or external clock input.
11	INT-EXT Clock Switch	S301	Selects internal 10-MHz clock output or external clock input.
12	OSC ADJ	C302	When required, used to adjust 10-MHz oscillator.
13	Voltage Selecting and Fused Connector	J5	Includes printed-circuit board for selecting transformer primary connections for 100-, 120-, 220-, or 240-volt operation, protective fuse, and three-prong receptacle connector for primary voltage and "earth" ground.

4-40. VOLTAGE SELECTION. To change the transformer primary connections for a specific operating voltage, without wiring modifications, proceed as follows:

a. Disconnect ac power cord from rear of instrument.

b. Slide open the plastic cover door on the voltage selecting and fused power connector J5. See Figure 4-3.

c. Pull the FUSE PULL lever to eject the fuse. Remove the fuse.

d. Using a suitable tool inserted in the centered hole of the printed-circuit board, remove the printed-circuit board.

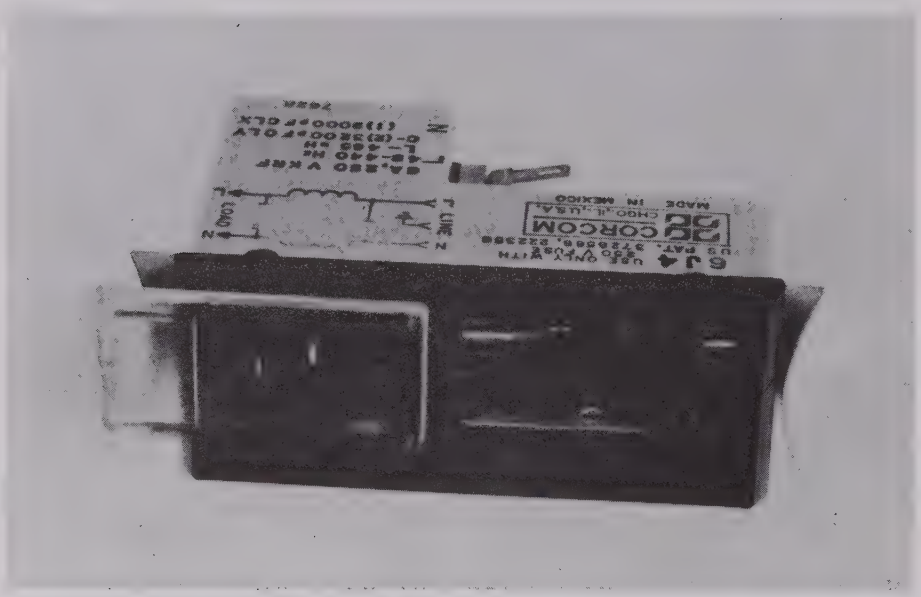
e. Select the desired operating voltage by orienting the printed-circuit board so as to position the printed circuit for the desired voltage on the top (visible) side of the board, next to the ac power connector. See Figure 4-3.

CAUTION

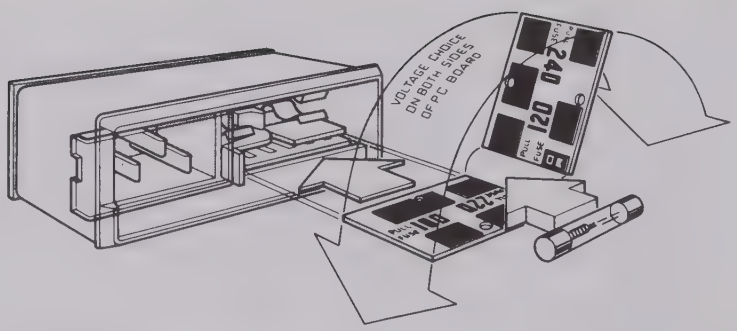
Failure to orient the printed-circuit board to match the operating voltage can cause improper operation or damage the instrument and void the warranty.

f. Rotate the FUSE PULL lever back into the normal position and reinstall the fuse into the fuse clips. Make sure the fuse value is correct.

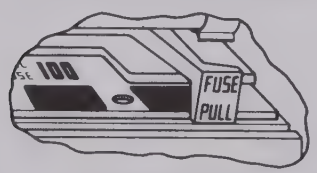
g. Close the plastic cover door and reconnect the ac power cord.



FRONT VIEW, COVER DOOR OPEN



Operating voltage is shown in module window.



ORIENTATION FOR VOLTAGE SELECTION

Figure 4-3. Voltage Selecting and Fused Connector J5, Printed Circuit Board Location and Orientation

4-41. CONNECTIONS.

4-42. The following connection requirements and precautions should be observed when connecting the generator to the equipment being tested or maintained:

a. Always use a minimum-length, 50-ohm coaxial cable assembly, such as the Ballantine Model 12249D, for the best pulse shape.

b. Always terminate the outputs of the generator at the far end of the connecting cable with a 50-ohm termination, such as the Ballantine Model 12630A.

c. Avoid capacitive loads at the termination when using the fast rise time output from the TRIGGER OUT connector J3 to minimize the degradation of the speed of the rise. Oscilloscope input capacities of 15 pF to 28 pF should not excessively load (slow down) the rise of the waveform.

d. When operating the generator from an external 10-MHz oscillator, the input signal must be greater than 2 volts peak-to-peak and not more than 5 volts peak-to-peak into the INT-EXT clock connector, J4; also, the INT-EXT clock switch, S301, must be in the EXT position.

e. The three marker output signals (H.F. OUT, MARKER OUTPUT, and TRIGGER OUT) are coincident and may be used simultaneously or individually.

4-43. Additional or similar connection requirements and precautions are noted as required in the following operation instructions.

4-44. TURN-ON PROCEDURE.

a. Before turning the generator on, disconnect the ac power cord from the rear connector, J5. Slide open the plastic window and check that the voltage-selecting, printed-circuit board in the connector is installed to match the primary power ac voltage (refer to paragraphs 4-39 and 4-40). The nominal voltage for which the transformer primary is connected by the printed-circuit board is printed on the board and is visible without removing the board.

CAUTION

Failure to match the primary power ac voltage will cause improper operation. It may also damage the generator and void the warranty. To reorient the board for a different voltage, refer to paragraph 4-40.

b. Reclose the plastic window and reconnect the ac power cord.

c. Set the POWER ON switch, S2, to the ON position. The POWER ON lamp should light as an indication that power has been applied.

NOTE

The generator can be used within 10 seconds after power is applied, at which time initial timing accuracy should be better than 0.25%. Generally, this accuracy is sufficient for oscilloscope time calibration. The oscillator oven requires 10 to 20 minutes to stabilize and bring the frequency accuracy within full specifications.

4-45. TIME CALIBRATION OF OSCILLOSCOPES.

4-46. MARKER OUTPUT.

a. Connect the appropriate marker output to the oscilloscope input by a 50-ohm coaxial cable with BNC terminations, such as the Ballantine Model 12249D. Also, at the oscilloscope end of the cable use a 50-ohm feedthrough termination, such as the Ballantine Model 12630A.

b. Set the TIME/DIV switch to the same setting as the oscilloscope time base to be calibrated.

c. Select the desired number of divisions spacing between time markers on the oscilloscope screen with the MULTIPLIER switch. This switch allows for a choice of one mark per division (X1), or one mark every other division (X2), or one mark at the left, center, and right marks of the graticule (X5), or one mark at the extreme left and one at the right full-scale line (X10). The following discussion applies to the NORMAL setting of the MULTIPLIER.

d. To measure the oscilloscope time calibration, set the first time mark on the leftmost graticule line and note the deviation of the marker nearest the rightmost (10 divisions) graticule line. Express the error as a percentage of deviation; that is, +0.1 division error is -1% oscilloscope time base calibration error.

4-47. H.F. OUTPUTS. Sine-wave outputs are available with periods of 2 ns, 5 ns, 10 ns, and 50 ns. Proceed as follows:

a. Connect the H.F. OUT of the 6130A to the oscilloscope input with a coaxial cable. Also use a 50-ohm termination unless the oscilloscope input is matched to 50 ohms, as is the case in most sampling oscilloscopes.

b. Set the HIGH FREQUENCY selector switch to the desired period and set the TIME/DIV switch of the oscilloscope accordingly.

c. If the oscilloscope will not trigger or synchronize on the high-frequency sine waves, then externally trigger the oscilloscope by connecting the TRIGGER OUT connector of the 6130A to the external trigger input of the oscilloscope. Refer to paragraph 4-56.

4-48. RISE TIME MEASUREMENTS.

4-49. Amplitude. It is usual to measure the rise time of an oscilloscope on the range where its

attenuator is in the straight-through position (maximum oscilloscope sensitivity). The 6130A trigger output provides 0.5 volt into 50 ohms or 1 volt unterminated and therefore will produce five divisions of deflection on oscilloscopes with sensitivities of 100 mV or even 200 mV per division. Unterminated operation is not recommended. For more sensitive oscilloscopes, 50-ohm, wide-band, coaxial attenuators (GR 874 Series) should be used. A 50-ohm feedthrough termination, such as the Ballantine Model 12630A, is recommended for use at the input of oscilloscopes having bandwidths greater than 1 MHz.

4-50. Cable Matching. The impedance of the interconnecting cable should be 50 ohms ±2%. Cable length should be kept as short as possible since cables longer than 4 feet will degrade the risetime. A slight reflection which may occur due to source mismatch can be removed by a 50-ohm termination at the oscilloscope input. This reflection will only be noticeable on very fast oscilloscopes and will occur approximately 3 ns/foot of cable after the main rise. Another effect of a proper termination is to reduce the source impedance to the oscilloscope. This results in a more accurate scope amplifier calibration. In practice the effect on the shape of response due to a terminating resistance on oscilloscopes of bandwidths up to 50 MHz is not normally noticeable. The 6130A rise time calibration feature is usable with oscilloscopes having bandwidths beyond 150 MHz.

4-51. Display Perturbations On The Rise Time. The overshoot on the positive-going edge of the fast-rise output of 2% maximum amplitude and approximately 2 ns duration is not visible on even a 150-MHz oscilloscope. Experience has shown that any preshoot, overshoot, or other positive-edge or top perturbations visible on oscilloscopes of up to 250 MHz bandwidth are invariably caused by the oscilloscope itself. This may be verified by (1) If other fast-rise sources are available by checking that the perturbations are independent of the source, or (2) If other oscilloscopes or channels are available by checking that applying the generator fast rise time to various channels does alter the perturbations.

4-52. Rise Time Measurement Accuracy. Before measuring the rise time of an oscilloscope, the calibration of the oscilloscope sweep range to be used should be checked. The 3-ns positive-going edge will increase the observed rise time of a 50-MHz oscilloscope (7 ns rise time) by only 5%. Therefore, for slower oscilloscopes the observed rise time may be taken to be the true rise time. For faster oscilloscopes the true rise time is given by:

$$\text{True Rise Time} = \sqrt{(\text{Observed Rise Time})^2 - (\text{Source Rise Time})^2}$$

The error due to taking the source rise time to be 3 ns when it differs from this by 10% is negligible ($< 5\%$) for oscilloscopes up to 50 MHz. To ensure accuracy always calibrate the time base of the oscilloscope in the region where rise time measurements are made. Rise time checks are usually made on the fastest sweep range, and the operator must correct for beginning trace nonlinearity and magnifier errors which often account for 8% to 10% timing error. Rise times should be measured 50 or more nanoseconds from the beinning of the visible oscilloscope trace and near the screen center for best results.

4-53. Measurement Instructions.

a. Connect fast-rise output to oscilloscope input with a 50-ohm coaxial cable and BNC terminations and a 50-ohm termination at the oscilloscope. If required, insert 50-ohm coaxial attenuators in the coaxial cable to attenuate from the 100 mV/division to the more sensitive mV/division range in use.

b. Select the desired repetition period with the TRIGGER PERIOD selector switch.

c. Use the oscilloscope vertical variable volts/division control and the position control to align the upper and lower levels of the waveform with the chosen 100% and 0% reference levels on the graticule. Measure the time difference between the 10% and 90% levels. See Figure 4-4.

4-54. Oscilloscope Bandwidth Calculation. The bandwidth of an oscilloscope having a Gaussian response amplifier (minimal overshoot) may be calculated from its rise time by the formula:

$$\text{Bandwidth (MHz)} = \frac{350}{\text{True Rise Time (ns)}}$$

$$= \frac{350}{\sqrt{(\text{Observed Rise Time})^2 - (\text{6130A Rise Time})^2}}$$

4-55. The bandwidth may be more accurately measured by a variable frequency sine wave source of known or constant amplitude. However, unless the oscilloscope is to be used to measure the amplitude of the sine waves near to its amplifier cutoff frequency, the measurement of rise time and the observation of the transient response are more useful in deciding what waveform distortions are controlled by the oscilloscope.

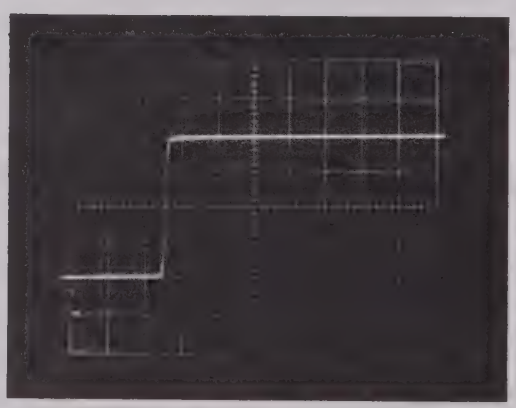


Figure 4-4. Rise Time Display

4-56. EXTERNAL TRIGGERING OF THE OSCILLOSCOPE.

4-57. NORMAL in the NORMAL mode frequencies of all outputs are obtained by division from one oscillator and any output may be used to externally trigger the oscilloscope. In general, the trigger frequency should be the same as or lower than the observed frequency. Varying the trigger frequency to the external trigger input of the oscilloscope will check the oscilloscope jitter factor and time calibration accuracy when signals of varying repetition rates are displayed on the oscilloscope. The trigger rate should always be lower than the observed frequency to avoid the appearance of an unwanted base line on the oscilloscope. Keeping the trigger repetition rate high will give the brightest display on the oscilloscope. As an operator convenience, the oscilloscope to be calibrated may be triggered externally at a fixed rate, for example, 1 ms, to avoid the need to adjust the oscilloscope triggering as fast time base ranges are checked on some oscilloscopes.

4-58. TRIGGER PERIOD MARKER LOCKOUT. In the TRIGGER PERIOD MARKER LOCKOUT mode selected by the MULTIPLIER switch, the TRIGGER OUT square wave is synchronized by the MARKERS to achieve time coincidence between the MARKER and TRIGGER outputs. This operational mode simplifies oscilloscope calibration by avoiding horizontal re-positioning of the scope trace when using external triggering. It also assists in the calibration of other time coincident displays such as radar A scope presentations. The TRIGGER PERIOD MARKER LOCKOUT mode is ONLY operative when the TRIGGER PERIOD is longer than the MARKER OUTPUT (VOLTS/DIV X MULTIPLIER setting). Whenever the selected MARKER OUTPUT period is equal to or longer than the selected TRIGGER PERIOD, the TRIGGER OUTPUT will disappear. Carefully observe these instructions to keep the MARKERS faster than the TRIGGER or use the NORMAL mode to avoid inadvertent loss of TRIGGER OUT square wave.

4-59. CALIBRATION OF DIGITAL COUNTER-TIMERS.

4-60. The functional operation of counter-timers may be verified in a manner similar to that described previously for oscilloscopes. The frequency period, period average, time interval A to B (common input), and other related functions can be checked. For best certification, lock the generator's clock and the counter's clock to obtain the highest resolution and minimum tracking error. The use of Option 14, the high-stability oscillator option, with the generator is recommended when the counter's internal clock is to be checked or aligned. If available, the use of a certified standard frequency source, such as a cesium clock or an "off the air" frequency standard is recommended.

4-61. OPERATION AS A FREQUENCY DIVIDER.

4-62. The generator may be operated from an external frequency source, such as an audio oscillator, a frequency standard, or a function generator. The input signal must be greater than 2 volts peak-to-peak into the 50-ohm BNC connector, J4, located on the rear panel. Connect the external signal to J4 and set the INT-EXT clock switch to the EXT position.

4-63. When using an external source to operate the marker and trigger outputs, the input frequency need not be 10 MHz; however, for the 2-volt peak input amplitude specification to apply, the input frequency must be in the range of 10 MHz to 100 kHz. Frequencies below 10 kHz can be accommodated provided the input signal does not exceed 5 V (dc + peak ac). Lower frequency signals should have a rate of rise exceeding 0.8 volt per microsecond. When an external frequency source is used, the 0.1 us MARKER OUTPUT (MULTIPLIER set to X1 position) and the 100 ns TRIGGER OUTPUT (TRIGGER PERIOD set to 100 nS position) will be the exact frequency of the external clock. The periods of all other triggers and markers will be multiplied by the ratio indicated by the MULTIPLIER and TRIGGER PERIOD switches. Therefore, the generator can operate as a complex digital frequency divider and time interval generator whose periods are determined by the ratios selected and subdivided from an external clock oscillator.

4-64. When using an external clock to operate the H.F. OUTPUT, the input frequency must be between the limits of 10 MHz ±100 Hz in order for the tuned high-frequency multiplier circuits to provide accurate timing and signal amplitudes. When the clock is not 10 MHz ±100 Hz, the 2 nS, 5 nS, 10 nS, and 50 nS HIGH FREQUENCY outputs are not available.

SECTION V

MAINTENANCE INSTRUCTIONS

5-1. INTRODUCTION.

5-2. This section contains information required for maintenance of the 6130A Time Mark Generator, including performance checks, preventive maintenance, troubleshooting, adjustment, and calibration procedures.

5-3. The generator uses premium components and with proper usage and maintenance will provide many years of satisfactory service. The manufacturer recommends that if the instrument is used for routine laboratory service, performance checks and preventive maintenance be performed every six months.

5-4. TEST EQUIPMENT.

5-5. The test equipment required to check, calibrate, and maintain the generator is listed in Table 2-1. Equivalent test equipment may be substituted if the recommended items are not available.

5-6. PERFORMANCE CHECKS.

5-7. GENERAL. The performance checks described in the following paragraphs are "in-cabinet" tests that compare the generator with the applicable specifications. A suggested test record form, shown in Figure 5-1, may be duplicated and used to record the results. These performance checks, paragraphs 5-9 through 5-14, should be performed and completed in the order listed before any attempt is made to calibrate the instrument. For optimum performance, after turn-on but before performing any check tests, allow the instrument to warm up for at least 2 hours. Also, all performance checks and calibrations should be performed at reference conditions of 22° C to 28° C (71.6° F to 82.4° F).

5-8. POWER LINE VOLTAGE SETTING. The primary winding of the transformer in the generator is connected to match the power line voltage being used by the orientation of the printed-circuit board in J5 (refer to paragraphs 4-39 and 4-40). The instrument as supplied is set for operation from 120 volts ac. The performance checks which follow reference 117 volts as the nominal voltage setting for the 120-volt primary power line voltage. For the other power line voltages of 100, 220, and 240 volts ac which can be used with the 6130A the following table lists the nominal midline voltages and the high-line and low-line voltages used for calibrating the instrument.

Line Voltage	Nominal Midline	Low Line	High Line
100 V	100 V	90 V	108 V
120 V	117 V	103 V	130 V
220 V	220 V	198 V	238 V
240 V	240 V	116 V	256 V

5-9. OSCILLATOR FREQUENCY ACCURACY AND STABILITY.

a. Interconnect the generator and the test equipment as shown in Figure 5-2.

b. Set the generator TIME/DIV switch to .1 uS and the MULTIPLIER switch to X1.

c. Connect the MARKER OUTPUT connector to the A input of the 5700A (Option 14) Frequency Counter. Use a 50-ohm feed-through termination at the counter end of the connecting cable.

d. Set the line voltage Variac to 117 V ac power.

e. If available, use a 1 MHz atomic frequency standard or a WWV receiver to clock the 5700A to ensure absolute accuracy of the frequency measurement.

f. Allow 20 minutes for warm-up, then measure the 0.1-us period (10 MHz frequency). Use the SENSITIVITY control on the 5700A to obtain a stable count. To meet specification, the counter must read within the range of 9, 999, 899 to 10, 000, 100 Hz. If desired, allow the equipment to warm up 2 hours and repeat the frequency measurement. The counter should read within the range of 9, 999, 929 to 10, 000, 081 Hz.

g. With line voltage set to 100 volts by the Variac, the counter should read within the range of 9, 999, 899 to 10, 000, 101 Hz.

h. Within line voltage set to 130 volts by the Variac, the counter should read within the range of 9, 999, 899 to 10, 000, 101 Hz.

i. Reset the line voltage to 117 volts.

5-10. MARKER OUTPUT.

a. Interconnect the generator and the test equipment as shown in Figure 5-3.

PERFORMANCE ASSURANCE TEST RECORD
BALLANTINE MODEL 6130A

Option No. _____ Date _____

Serial No. _____ Performed By _____

Note: All tests shall be performed at reference conditions of 22° C to 28° C.

1. OSCILLATOR FREQUENCY ACCURACY AND STABILITY (Paragraph 5-9).

a. 115 (230) Volts Power Line (5-9f) _____ MHz
b. Optional High-stability Check (2 Hours) (5-9f)
Starting Time _____ h _____ min
Test Time _____ h _____ min
c. Low Line Voltage Check 90 (180) Volts (5-9g) _____ MHz
d. High Line Voltage Check 135 (260) Volts (5-9h) _____ MHz

2. MARKER OUTPUT (Paragraph 5-10).

6130A		Oscilloscope	Markers	Amplitude
TIME DIV	MULTIPLIER	TIME/DIV	Per Line	>1 Div
0.1 us	X1	1 us X10 (.1 us)		
0.2 us	X1	2 us X10 (.2 us)		
0.5 us	X1	.5 us		
1 us	X1	1 us		
2 us	X1	2 us		
5 us	X1	5 us		
10 us	X1	10 us		
20 us	X1	20 us		
50 us	X1	50 us		
.1 ms	X1	.1 ms		
.2 ms	X1	.2 ms		
.5 ms	X1	.5 ms		
1 ms	X1	1 ms		
2 ms	X1	2 ms		
5 ms	X1	5 ms		
10 ms	X1	10 ms		
20 ms	X1	20 ms		
50 ms	X1	50 ms		
.1 s	X1	.1 s		
.2 s	X1	.2 s		
.5 s	X1	.5 s		
.5 s	X2	.5 s		
.5 s	X5	.5 s		
.5 s	X10	.5 s		
.2 s	X10	.2 s		

3. TRIGGER PERIOD (Paragraph 5-11).

6130A TRIGGER PERIOD	Oscilloscope TIME/DIV	Square Wave per cm	Amplitude >1 cm
100 ns	1 us X10 (.1 us)		
1 us	1 us		
10 us	10 us		
100 us	100 us		
1 ms	1 ms		
10 ms	10 ms		
100 ms	100 ms		
1 s	1 s		

Figure 5-1. Performance Assurance Test Record Form (Sheet 1 of 2)

4. TRIGGER OUTPUT RISE TIME (Paragraph 5-12).		
Amplitude (5-12e)	> .5 volt	_____ volts
Overshoot (5-12f)	< 2%	_____ volts
Rise Time (5-12g)	< 3 ns, 10 to 90%	_____ volts
5. HIGH FREQUENCY OUTPUT (Paragraph 5-13).		
50 ns Amplitude (5-13b)	> 0.5 volt	_____ volts
50 ns Frequency (5-13c)		_____ MHz
10 us Amplitude (5-13d)	> 0.5 volt	_____ volts
10 us Frequency (5-13d)		_____ MHz
5 ns Amplitude (5-13d)	> 0.5 volt	_____ volts
5 ns Frequency (5-13d)		_____ MHz
2 ns Amplitude (5-13d)	> 0.5 volt	_____ volts
2 ns Frequency (5-13d)		_____ MHz
6. EXTERNAL CLOCK INPUT (Paragraph 5-14)		
10 MHz to 100 kHz at 2 V p-p drive (5-14f)		

Figure 5-1. Performance Assurance Test Record Form (Sheet 2 of 2)

b. Connect the MARKER OUTPUT connector to the CH1 input connector of the Ballantine 1066B Oscilloscope. Connect a 50-ohm feed-through termination at the oscilloscope end of the connecting cable.

c. Set the TIME/DIV switch to .1 uS and the MULTIPLIER switch to NORMAL X1.

d. Set the 1066B Oscilloscope controls as follows:

CH1 VOLTS/CM	.5 V
CH1 Coupling	DC
CH1 Position	Centered
CH2 Position	OFF
TIME/CM	1 uS
PULL x 10 MAG	Pulled Out (X10)
TRIG SELECT	CH1 +
Trigger Coupling	AC and NORMAL

e. Use trigger LEVEL control and trace-position controls to position a stable display on screen.

f. Observe a marker pulse on the oscilloscope at each vertical line of the CRT graticule. Continue to observe the same display but with somewhat narrower positive-going marker pulses at each TIME/DIV and oscilloscope sweep range through 0.5 second. Do not use the X10 magnifier on the oscilloscope at time-base speeds slower than 0.5 us. Observe that the minimum marker pulse amplitude displayed on the oscilloscope is greater than 1 cm (0.5 volt) for each of the 21 MARKER OUTPUT settings.

g. Set the MULTIPLIER control to NORMAL X2 and the oscilloscope TIME/CM switch at .5 SEC. Observe six pulses with one pulse coincident with alternate graticule lines, which checks the 1-second marker output.

h. Set the MULTIPLIER control to NORMAL X5. Observe three marker pulses on the screen, one at the left, one at the center, and one at the right graticule line, which checks the X5 marker multiplier.

i. Set the MULTIPLIER control to NORMAL X10. Observe two markers on the screen, one at the extreme left and one at the extreme right graticule line, which checks the 5-second marker and the X10 multiplier.

j. With the MULTIPLIER control still set to NORMAL X10, set the TIME/DIV switch to .2 S and the oscilloscope TIME/CM control to .2 SEC. Observe that only two pulses appear on the screen, which checks the 2-second marker.

5-11. TRIGGER PERIOD.

a. Continue with the control settings of paragraph 5-10 and the test setup of Figure 5-3, except disconnect the cable from the MARKER OUTPUT connector and reconnect it to the TRIGGER OUT connector. Also, set the TRIGGER PERIOD to 100 nS and the oscilloscope TIME/CM switch to 1 us, and activate the X10 MAG knob for the X10 magnifier position for a sweep of 0.1 us/cm.

b. Observe a square wave display on the oscilloscope screen. Its amplitude must be greater than

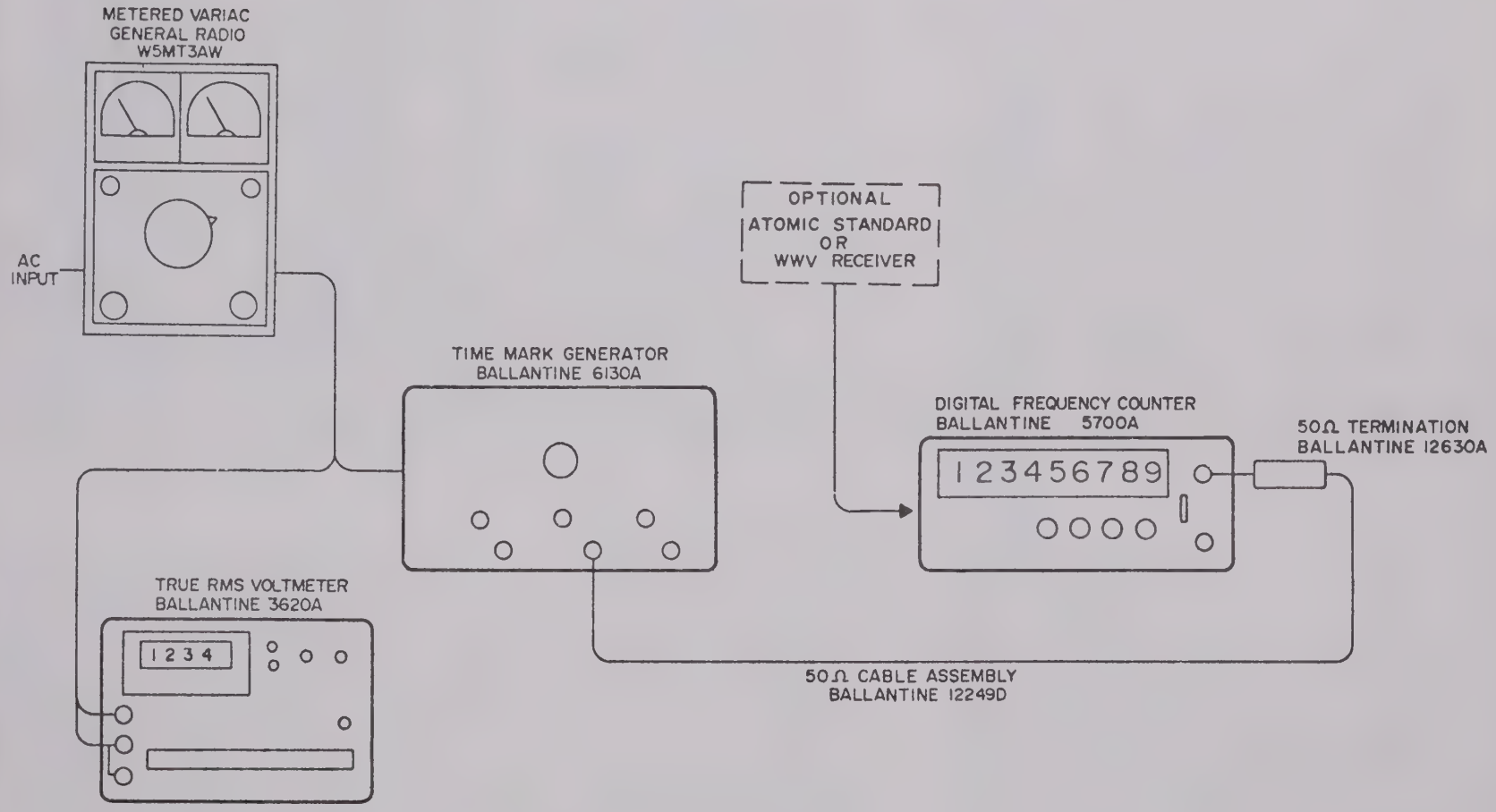


Figure 5-2. Clock Frequency Check, Bench Test Setup

1 cm and the period of each full square wave must occupy 1 cm.

c. Change the TRIGGER PERIOD to 1 uS and reset the oscilloscope X10 MAG knob to the X1 position (sweep of 1 us per cm). Observe a square wave as in the preceding step b.

d. In sequence, change the TRIGGER PERIOD and the oscilloscope TIME/CM settings to 10 uS, 100 uS (.1 mS), 1 mS, 10 mS, 100 mS (.1 SEC), and 1 S (1 SEC). Observe the same 1 cm square wave as in the preceding step b on each of the paired settings.

5-12. TRIGGER OUTPUT RISE TIME.

a. Interconnect the generator and the test equipment as shown in Figure 5-4.

b. Connect the TRIGGER OUT connector of the 6130A to the sampling oscilloscope through a short (8-inch) 50-ohm cable. Use a 20-dB (X10) coaxial 50-ohm attenuator at the input of the oscilloscope and use a BNC to GR adapter to connect the attenuator to the 50-ohm cable BNC connector. Set the oscilloscope to 20 mV vertical sensitivity, internal trigger, and 1 ns per cm sweep speed.

c. Set the TRIGGER PERIOD to 100 nS.

d. Obtain a stable display of a positive-going edge of the square wave on the screen of the oscilloscope.

e. Observe that the leading edge of the waveform on display is at least 2.5 cm peak-to-peak. This amplitude verifies a trigger-out signal greater than 0.5 volt since the oscilloscope sensitivity is 20 mV X10 or 200 mV per cm.

f. Observe that the overshoot on the top of the leading edge is no greater than 2% of the 0% to 100% peak-to-peak value of the TRIGGER OUT square wave.

g. Observe that the 10% to 90% risetime of the positive-going rise is no more than 3 ns (1.5 cm).

5-13. HIGH FREQUENCY OUTPUT.

a. Continue with the test setup shown in Figure 5-4. Disconnect the cable from the TRIGGER OUT connector and reconnect it to the H.F. OUT connector. Set the HIGH FREQUENCY switch to 50 nS and set the sampling oscilloscope time base to 50 ns per cm. Obtain a stable sine-wave display on the oscilloscope.

b. Observe a sine wave greater than 2.5 cm peak-to-peak, which indicates that the H.F. OUT signal is greater than 0.5 volt peak-to-peak into 50 ohms, since the oscilloscope sensitivity is 20 cm V X10 or 200 mV per cm. Also, note that the cycle-to-cycle amplitude does not vary by more than 5% peak-to-peak at the top side of the displayed sine wave. The other side is uncontrolled.

c. Observe a sine wave for each graticule line to indicate that the H.F. OUT frequency is 50 ns. Then, disconnect the short BNC cable of the BNC to GR adapter and connect it into the 50-ohm (B) input of the 500 MHz frequency counter. Set the counter to 1 second for a nine-digit display. Observe that the counter reads in the range of 20,000,201 to 19,999,799 Hz. Reconnect the BNC cable to the oscilloscope.

d. In sequence, set the HIGH FREQUENCY switch and the sampling oscilloscope time base to 10 nS, 5 nS, and 2 nS. For each setting, repeat the observations of amplitude as in the preceding step b. Repeat the sine-wave period check of 1 cycle/cm as in the preceding step c. For each HIGH FREQUENCY setting also make the counter check of preceding step c with the following limits:

10 nS: 99,998,999 through 100,001,001 Hz
5 nS: 199,997,999 through 200,002,001 Hz
2 nS: 499,994,999 through 500,005,001 Hz

5-14. EXTERNAL CLOCK INPUT.

a. Interconnect the generator and the test equipment as shown in Figure 5-5.

b. Set the TIME/DIV switch to 1 uS and the MULTIPLIER to X1. Set the rear-panel INT-EXT clock switch to the EXT position. (These control positions check the shaper and digital-logic trigger circuitry for external clock input verification.)

c. Set the dual-trace oscilloscope controls as follows:

CH1 VOLTS/CM	.5 V
CH1 Coupling	AC
CH1 Position	Centered
CH2 Position	OFF
TIME/CM	1 mS
TRIG SELECT	FREE RUN

The oscilloscope should display a free-running, unsynchronized display of CH1 only.

d. Set the 500 MHz frequency counter to 1 second and a nine-digit display. Connect a 50-ohm feed-through termination to the high-impedance (A) input.

e. Connect the MARKER OUTPUT through the 50-ohm termination to the high-impedance, low-frequency input of the 500 MHz counter. Connect a BNC Tee-connector to the CH1 input of the 1066B Oscilloscope and connect the 50-ohm output of the 10-MHz oscillator and the EXT clock input (INT-EXT clock switch set to EXT) to the Tee-connector arms.

f. Adjust the oscillator amplitude to produce a 4 cm peak-to-peak vertical display on the oscilloscope. Vary the frequency of the oscillator from 10 MHz to 100 kHz, maintaining the oscilloscope display of a constant 4 cm (2 volts) peak-to-peak amplitude. Note the frequency on the counter which should show

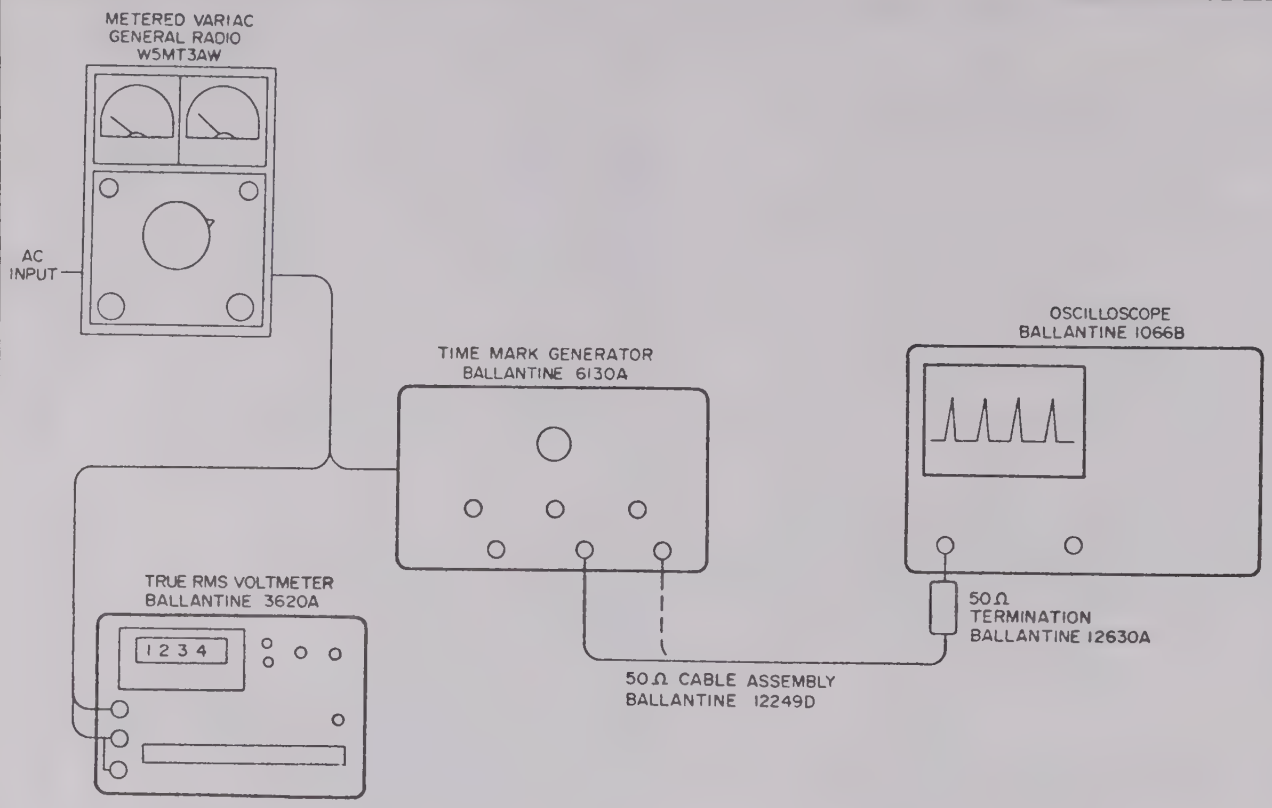


Figure 5-3. Trigger and Marker Amplitude Check, Bench Test Setup

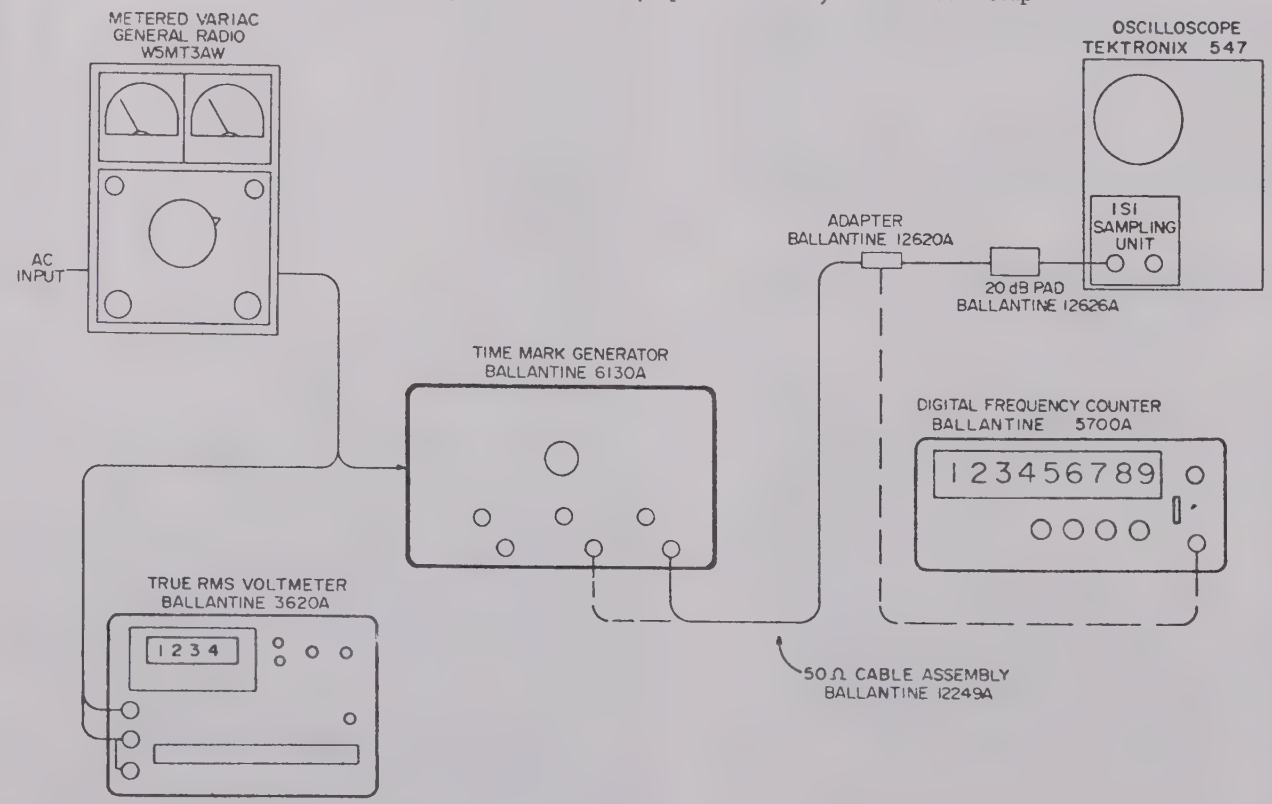


Figure 5-4. Trigger Rise Time and H.F. OUT Check, Bench Test Setup

continuous frequency coverage from 1 MHz to 10 kHz, which indicates an external clock input at 2 volts peak-to-peak over the entire input frequency range of 10 MHz through 100 kHz. The counter shows the input frequency divided by 10 since the 6130A TIME/DIV switch is set to 1 uS which is the 0.1-us input divided by 10.

5-15. CALIBRATION AND ALIGNMENT PROCEDURES.

5-16. GENERAL. The following alignment and calibration procedures are used to adjust and align the instrument to its performance specifications. If the instrument cannot be adjusted properly, refer to the troubleshooting and fault-finding procedures in paragraph 5-27 and Table 5-1.

5-17. REMOVAL AND REPLACEMENT OF COVERS. The top and bottom covers of the instrument are each retained by four half-turn plastic fasteners. To remove the covers, turn each fastener a half turn to disengage the fastener pawl from under the end-frame castings. Lift the covers up and away from the instrument. To replace the covers, reverse the procedure. Make sure the covers slide into the retaining slots provided in the side extrusions and that all pawls are engaged properly; turn the pawls with care to avoid breakage.

5-18. INTERNAL ADJUSTMENTS AND TEST POINTS. Internal adjustments and test points are identified and their locations are shown on Figure 5-6.

5-19. POWER SUPPLY CHECK.

a. Connect the ac power line input to the generator through a Variac, or similar line voltage control unit, and use a true rms voltmeter, such as the Ballantine Model 3620A, to measure the input line voltage to the 6130A.

b. Connect a digital multimeter, such as the Ballantine Model 3028A, to TP3 (+5 volt supply) and any convenient case or circuit ground. Set the DMM to the 10-volt dc range.

c. Vary the ac input voltage from 100 to 130 volts and note that the +5 volt bus reads in the range of +4.7 to +5.3 volts with less than ±0.1 volt change due to line voltage variation.

d. Connect the DMM to TP4 (-12 volt supply) and repeat the preceding step c. Check that the -12 volt bus reads in the range of -11.3 to -12.7 volts with less than ±0.2 volt change due to line voltage variation.

e. Readjust the Variac to the midline 117 volts and disconnect the DMM.

5-20. PRELIMINARY CONTROL SETTINGS. Prior to calibrating or adjusting the generator set the controls initially as follows:

HIGH FREQUENCY	50 nS
TIME/DIV	.1 uS
MULTIPLIER	X1
TRIGGER PERIOD	100 nS
INT-EXT Clock Switch	INT

5-21. CLOCK FREQUENCY ADJUST (C302).

NOTE

Before making any adjustment of the clock frequency or multiplier tuning, allow at least 2 hours warmup at reference conditions. Make all adjustments in the sequence listed.

a. Interconnect the generator and the required test equipment as shown in Figure 5-2. Use a frequency counter with a certified high-stability clock, such as the Ballantine Model 5700A with Option 14, connected to the MARKER OUTPUT connector. Be sure that the clock frequency in the counter is fully stabilized and accurate. Use a frequency standard, if available, for the counter clock.

b. The frequency counter must read in the range of 10,000,081 to 9,999,919 Hz when measuring the 0.1 us MARKER OUTPUT. If the frequency is near or over the limit, adjust C302 until the counter reads in the range of 10,000,010 to 9,999,990 Hz. If C302 does not have sufficient range, select a value for C301 (typical values for C301 are 5, 12, 20, 27, and 36 pF) to bring the adjustment of C302 within range, or replace the quartz crystal and oven assembly if the frequency adjustment cannot be centered on 10 MHz. If the clock of the generator is not set properly to 10 MHz, the accuracy of all generator outputs will be adversely affected.

5-22. 10-MHz TUNED AMPLIFIER ADJUST (C308).

a. Interconnect the generator and the required test equipment as shown in Figure 5-4. Connect a sampling oscilloscope, such as the Tektronix 547 with S101 plug-in, to the H.F. OUT connector. Set the sampling oscilloscope time base to 50 ns/cm. Connect the 100 nS TRIGGER OUTPUT of the 6130A to the external trigger input of the sampling oscilloscope. Set the oscilloscope to external positive trigger and adjust the sweep triggering for a stable triggered display.

b. Set the sampling oscilloscope vertical sensitivity to 20 mV/cm. The oscilloscope is then calibrated to

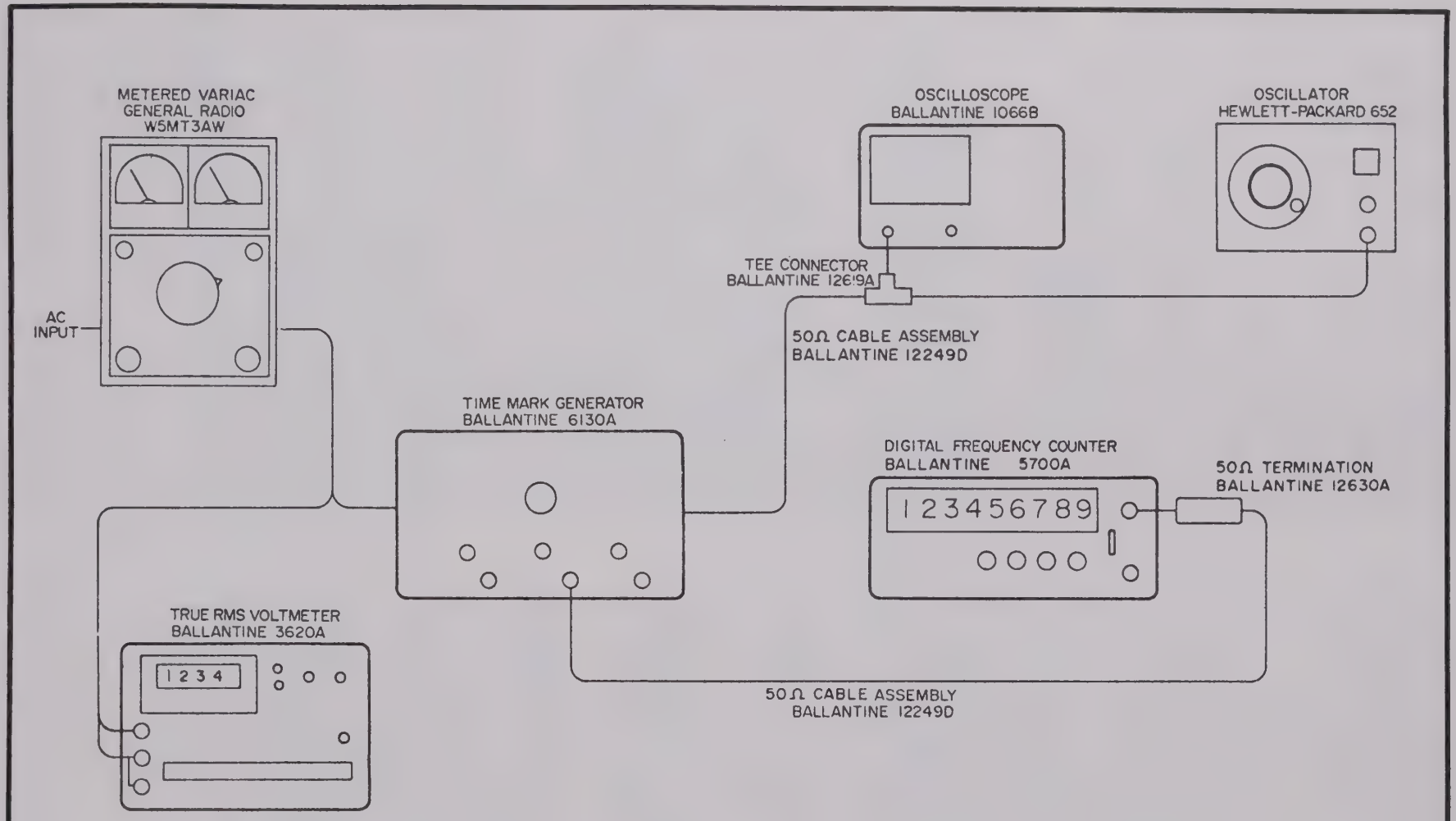


Figure 5-5. External Clock Input Check, Bench Test Setup

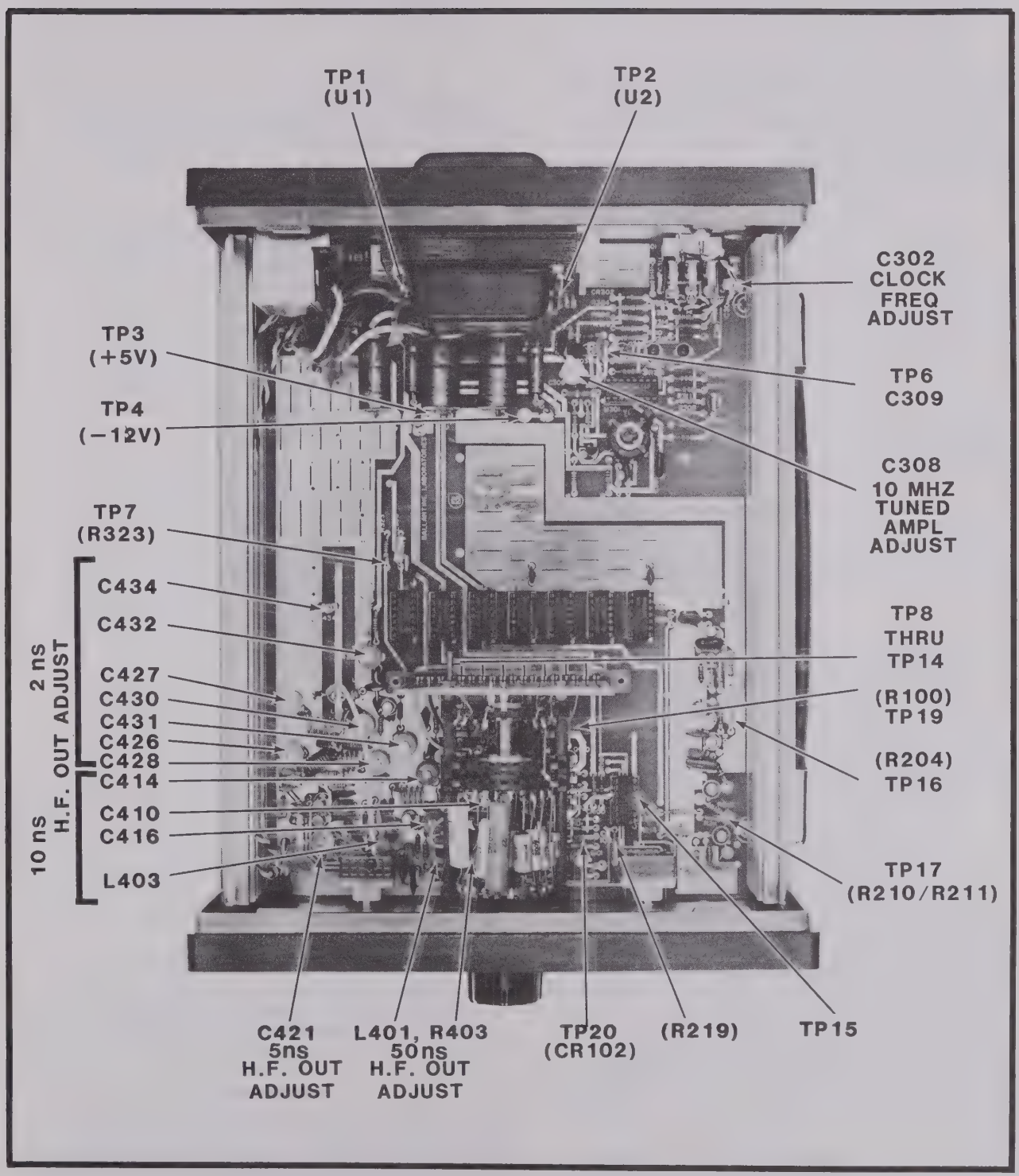


Figure 5-6. Internal Adjustments and Test Points

200 mV/cm since the input signal from the generator is reduced by an X10 coaxial attenuator. Observe a 50 ns (20 MHz) sine wave on the oscilloscope.

c. Adjust C308 for maximum sine-wave amplitude on the oscilloscope. If no tuning or too little tuning is noted, check Q305, Q400, and Q401, as well as their associated components.

d. If the 10-MHz tuned amplifier is not performing its function as a 10-MHz filter, the 50-ns through 2-us multipliers will not adjust properly, or will not have sufficient output amplitude, or will show undue distortion. Note that the input signal to the 10-MHz tuned amplifier must be "on frequency" and reasonably sinusoidal in waveform.

5-23. 50-ns H.F. OUT ADJUST (L401, R403).

a. With all generator and test equipment controls remaining as in the preceding paragraph 5-22, observe the 50-ns sine-wave display on the oscilloscope.

b. Adjust L401 for maximum output amplitude.

c. If necessary to improve the flatness of the output amplitude from cycle to cycle, adjust C308 to change the drive slightly to the 20-MHz doubler. Do not change the setting of C308 too much; if necessary, repeat the preceding procedure of paragraph 5-22.

d. Adjust R403 for the best cycle-to-cycle flatness of amplitude.

e. Check that the peak-to-peak sine-wave amplitude is greater than 0.5 volt (2.5 divisions).

NOTE

The preceding adjustments interact. Cycle-to-cycle flatness is an indication of minimal intermodulation distortion which will adversely affect the following multipliers and cause poor calibrator performance with temperature changes. Flatness should be within 1% on a cycle-to-cycle basis at 25° C in the 20-MHz doubler.

5-24. FLATNESS ADJUSTMENT.

a. Adjust the vertical display on the sampling oscilloscope to 5 cm with the variable VOLTS/DIV control on the oscilloscope.

b. Remove the 20 dB (X10) coaxial attenuator from the vertical input of the oscilloscope. Each division on the oscilloscope graticule now represents 2% of the total signal amplitude.

c. Adjust the sampling oscilloscope DC OFFSET control to position the bottom of the sine-wave display on the screen.

d. Turn the oscilloscope time-position control over a range of at least 25 displayed sine waves. Note the amplitude differences between the various peaks of the sine waves. The maximum to minimum crest difference should not exceed 6/10 of a division or 1.2%. This tolerance is for reference only and is not a performance specification.

5-25. 10-ns H.F. OUT ADJUST (C410, C414, C416, L403).

a. With all generator and test equipment controls remaining as in the preceding procedure, change the oscilloscope time base to 10 ns per division and the HIGH FREQUENCY switch to 10 nS. Observe a stable 100-MHz (10 ns) sine wave on the sampling oscilloscope.

b. Adjust C410 and C414 simultaneously for best flatness and maximum amplitude of the 10 ns H.F. OUT marker display on the sampling oscilloscope.

c. Adjust C416 and L403 for maximum sine-wave amplitude.

d. Check that the cycle-to-cycle amplitude modulation of the sine wave does not exceed 5% at 25° C. Use the procedure outlined in step d. of paragraph 5-24. This tolerance is for reference only and is not a specification.

e. If reasonable modulation percentage is not achievable, then the multipliers following will not function properly. Corrective measures may involve replacing a damaged or misshapen coupling transformer, T402, or an unmatched pair of transistors, Q402 and Q403. The beta (current gain) of these transistors should be matched within 25% to minimize intermodulation distortion. Always replace Q402 and Q403 as a matched pair (Ballantine P/N 10-10104-1).

f. The output amplitude of 10 ns sine-wave markers should exceed 0.5 volt peak-to-peak (2.5 divisions). If this is not achievable, replace Q404, check the value of C418 and C419, check rotary switch section S11B, or check the resonant frequency of the series circuit in the base of Q404, as well as the resonant frequency of its collector tank. Also, check the quintupler components and the proper adjustment of the preceding tuned circuits.

5-26. 5-ns H.F. OUT ADJUST (C421).

a. With all generator and test equipment controls remaining as in the preceding procedure, change the sampling oscilloscope time base to 5 ns per division and the HIGH FREQUENCY switch to 5 ns. Observe a stable 200-MHz (5 ns) sine wave on the oscilloscope.

b. Adjust C421 for maximum 200 MHz (5 ns) sine wave display on the sampling oscilloscope. The amplitude must exceed 0.5 volt (2.5 divisions) peak-to-peak. If not obtainable, check Q405 and Q406 and associated components. Check T404 and replace if damaged or misshaped.

c. Sine-wave cycle-to-cycle amplitude modulation should not exceed 5% at 25° C. Use the procedure described in paragraph 5-24. If intermodulation is excessive, replace Q405 and Q406 with transistors whose beta (current gain) is matched within 25%, and carefully adjust L403 no more than one-half turn for optimum amplitude flatness of the 5-ns H.F. OUT sine wave. The cycle-to-cycle amplitude modulation tolerance is for reference only and is not a specification.

5-27. 2-ns H.F. OUT ADJUST (C426, C427, C428, C430, C431, C432, C434).

a. With all generator and test equipment controls remaining as in the preceding procedure, change the sampling oscilloscope time base to 2 ns per division and the HIGH FREQUENCY switch to 2 nS. Observe a stable 500 MHz (2 ns) sine wave on the oscilloscope.

b. Observe that the 5-ns frequency output provides one sine wave per division on the scope graticule and that the sine wave displayed is at least 0.5 volt (2.5 divisions) peak-to-peak.

c. Adjust C426, C430, and C434 for maximum signal amplitude.

d. Adjust C427, C428, C431, and C432 for best flatness and amplitude.

NOTE

The adjustments of C426, C427, C428, and C430 interact. Repeat steps b and c as necessary for best tuning. Also, do not make any of the capacitor adjustments randomly or too far removed from the original settings. The controls interact and a number of combinations may produce a 500-MHz (2 ns) output; however, only one combination produces maximum amplitude and maximum flatness.

e. If a 0.5-volt amplitude is not achievable, check Q407, CR401, and the associated components, including all transformers and inductors in the 500-MHz quintupler. Check that the printed circuit board and components are clean and free of flux or other contaminants which may lower the Q of tank circuits and the strip line filter and cause a loss of the 2-ns output signal amplitude.

5-28. TROUBLESHOOTING AND FAULT FINDING.

5-29. The troubleshooting procedures should be performed only when the instrument cannot be calibrated using the procedures of paragraphs 5-15 through 5-27. Should the instrument be inoperative or completely out of specifications, proceed with the following fault-finding procedures:

a. Carefully examine the instrument and check for any visual evidence of trouble. Check for broken wires, burned resistors, loose components, and shorted, open, or defective solder joints on the printed circuit board. Check for separation of printed circuit board lands and pads. Check for open, defective, or intermittent switches. Check that connectors are clean and mate properly. Check that the instrument circuit ground is shorted to the chassis ground.

b. Understand and be familiar with the circuit theory of Section IV. Use the functional block diagram, Figure 4-1, and the schematic diagram, Figure 6-1, to isolate the probable circuit areas which may cause the problem. Always check the power supply voltages and check for oscillations in the circuitry. Then, refer to the fault-finding and troubleshooting hints for the circuit which follow. Table 5-1 is a troubleshooting chart which gives some probable corrections for specific problems.

5-30. PRINTED WIRING BOARD REPAIR AND CLEANING.

5-31. The generator uses an etched-copper printed circuit board. The main printed circuit board uses plated-through holes. To prevent damage to the circuit board and components, observe the following instructions when soldering:

a. Use a low-heat-capacity soldering iron with a 700° F tip, 1.5 mm (1/16 inch) to 2.5 mm (3/32 inch) wide, similar to Weller Model No. W-TCP, 60 watts.

b. Be sure that the soldering iron tip is grounded to the power line "earth" ground to avoid possible overvoltage damage to semiconductor and tantalytic capacitors. Also, "earth" ground the case of the instrument.

c. When removing a component, clip a heat sink, such as long-nose pliers, tweezers, or alligator clips, to the component leads, as close as possible to the body of the component, to ensure minimum heating of the component when soldering.

d. Place the soldering iron directly on the component lead on the conductor side of the printed circuit board. Use a desoldering tool such as the SOLDAPULLT, manufactured by Edsyn Products, to remove all solder and free the component lead.

e. Straighten the component lead with long-nose pliers and remove the component from the board.

f. If a component is obviously faulty or damaged, clip the leads close to the body of the component and remove the leads remaining from the conductor side of the board.

g. Use a short soldering cycle since excessive or prolonged heat may destroy the laminate board and lift the copper conductors from the circuit board, or cause immediate degradation or latent damage of the components.

h. Clean the component lead holes by heating the solder on the circuit board conductor pad, quickly removing the soldering iron, and inserting a pointed

Table 5-1. Troubleshooting Aids

SYMPTOM	PROBABLE FAULT
1. Front panel pilot lamp does not illuminate when POWER ON switch S2 is ON.	AC power cord not connected properly. Check power line fuse F1. Check pilot lamp. Check +5 volt supply and U1.
2. No output signals from any connector.	Check that clock mode switch S301 on rear panel is set to INT position. Check +5 and -12 volt supplies. Check 10-MHz crystal oscillator, Y1, U301, Q301, Q302, Q303, and Q304. Check that 10-MHz signal is present at J4 and TP6 (emitter of Q304).
3. No marker output when TIME/DIV switch S10 is set to .1 uS and MULTIPLIER switch S12 is set to X1.	Check 10-MHz clock. Check proper operation of shaper in TIME/DIV switch via C21. Check 1.0 MHz pulses at TP19, the collector of Q100, and the base of Q101. Check Q101.
4. No marker output when TIME/DIV switch S10 is set to .1 uS and MULTIPLIER switch S12 is set to X2, X5, or X10.	Check previous Symptom No. 3. Check U18 and replace if necessary. Check S12. (This checks the MULTIPLIER circuit for all TIME/DIV ranges.)
5. No trigger output when TRIGGER PERIOD switch S13 is set to 100 nS.	Check 10-MHz clock as in previous Symptom No. 3. Check for 10-MHz signal at TP8 and R200. Trace 10 MHz to TP16, TP17, and the collector of Q204 at R217. Check that the base of Q204 is -7.2 V with respect to signal ground.
6. Insufficient trigger output amplitude at J3, TRIGGER OUT connector.	Check Q200, Q201, Q202, Q203, and especially Q204. Check that voltage at base of Q204 is -7.2 V. Check R215, R216, R217, and R218. Replace if off value.
7. No trigger output at 1 uS or no marker output at .2 uS, or .5 uS, or 1 uS.	Check U10 and U11. Check marker circuits as in previous Symptom No. 3 and 4. Check trigger circuits as in previous Symptom No. 5 and 6. Check for 1-MHz signal at TP9.
8. No trigger output at 10 uS or no marker output at 2 uS, or 5 uS, or 10 uS.	Check U12. Check for 100-kHz signal at TP10. Recheck as in previous Symptom No. 7.

Table 5-1. Troubleshooting Aids (Cont)

SYMPTOM	PROBABLE FAULT
9. No trigger output at 100 uS or no marker output at 20 uS, or 50 uS, or .1 mS.	Check U13. Check for 10-kHz signal at TP11. Recheck as in previous Symptom No. 8.
10. No trigger output at 1 mS or no marker output at .2 mS, or .5 mS, or 1 mS.	Check U14. Check for 1-kHz signal at TP12. Recheck as in previous Symptom No. 9.
11. No trigger output at 10 mS or no marker output at 2 mS, or 5 mS, or 10 mS.	Check U15. Check for 100-Hz signal at TP13. Recheck as in previous Symptom No. 10.
12. No trigger output at 100 mS or no marker output at 20 mS, or 50 mS, or .1 S.	Check U16. Check for 10-Hz signal at TP14. Recheck as in previous Symptom No. 11.
13. No trigger output at 1 S.	Check U17. Check for 1-Hz signal at TP15.
14. Frequency modulation on MARKER OUTPUT and TRIGGER OUT or faulty operation at high or low power line voltage.	Check that +5 volt supply at high and low power line is +4.5 to +5.4 volts. Check for less than 50 mV power frequency related ripple. If necessary, replace U1, CR1, C1, or C2. Check that -12 volt supply at high and low power line is -11 to -13 volts. Check for less than 50 mV power frequency related ripple. If necessary, replace U2, CR2, C3, C4, or C5. Check 10-MHz clock and U10 through U18 at TP9 through TP15 by following signal and noting incidence of frequency modulation. Replace defective IC when first noting modulation.
15. No output on any HIGH FREQUENCY range.	Check that 10-MHz clock is on frequency ±100 Hz. If using EXT CLOCK input, check that frequency is 10 MHz ±100 Hz. Check that 10 MHz appears at TP7, the 10-MHz filter output. If previous checks O.K., begin at the 20-MHz doubler, 50 nS,HIGH FREQUENCY range; then proceed to the 10 nS, 5 nS, and 2 nS ranges. Be sure that a sampling oscilloscope and other required test equipment are available. Use of lower frequency oscilloscopes will not provide fault location or proper calibration. Always terminate J1, the H.F. OUT connector, in 50 ohms when troubleshooting the multipliers.
16. No output or too little amplitude on the 50-nS range.	Recheck Symptom No. 15. Check Q400 and Q401. Check that the dc voltage at the junction of C401 and R402 is approximately +0.56 V. Recalibrate the 20-MHz doubler as prescribed in paragraph 5-23.

Table 5-1. Troubleshooting Aids (Cont)

SYMPTOM	PROBABLE FAULT
17. Poor cycle-to-cycle amplitude stability on the 50-nS range.	Touch-up setting of R403, the 20-MHz balance adjustment. Recheck Symptom No. 16 and recalibrate the 20-MHz doubler and 10-MHz filter, if necessary.
18. No output or too little amplitude on the 10-nS range.	Be sure the proper output and amplitude exists on the 50-nS range output. Check that both sides of the printed wiring board are clean and free of dust, grease, or other contamination. Clean with Freon cleaner if necessary. Check that all air-spaced transformers and other components are undamaged and in good condition. Check Q402, Q403, and Q404. Check that the dc voltage at the junction of C407 and R409 is approximately +0.13 V. Recalibrate 100-MHz multiplier as prescribed in paragraph 5-25.
19. No output or too little amplitude on the 5-nS range.	Be sure the proper output amplitude and cycle-to-cycle amplitude leveling exists for the 10-nS output. If not, recheck Symptom No. 18. Check that the dc voltage at the junction of C420 and R417 is approximately +0.33 V. If not, check S11B, T403, Q405, and Q406. Be sure the printed wiring board is clean and that all air-spaced transformers and components are undamaged and in their factory-installed positions. Recalibrate 200-MHz doubler as prescribed in paragraph 5-26.
20. No output, too little amplitude, or excessive cycle-to-cycle amplitude change on the 2-nS range.	Be sure the proper output amplitude and cycle-to-cycle amplitude leveling exists for the 10-nS rnage. If not, recheck Symptom No. 18. Check that both sides of the printed wiring board and strip line are clean and free of dust, grease, or other contamination. Clean if necessary using Freon spray cleaner. Check that all air-spaced coils and transformers are undamaged and in their factory-installed positions. Check Q402 and CR401. Recalibrate 500-MHz quintupler as prescribed in paragraph 5-27. If proper output cannot be obtained, replace CR401 and any coils or capacitors which may not tune properly as required in the recalibration procedure.
21. Improper output amplitude and rise time on the trigger output.	Test on the 100-nS TRIGGER PERIOD range. Use a sampling oscilloscope with 50-ohm input and short 50-ohm input cable to connect to J3. Check Q200, Q201, Q202, Q203, and Q204. Replace if necessary. Check CR201 and CR202.

Table 5-1. Troubleshooting Aids (Cont)

SYMPTOM	PROBABLE FAULT
21. (Continued)	Check condition and value of all components and replace if necessary. Check that the dc voltage at the base of Q204 is approximately -7.2 V.

nonmetallic object, such as a toothpick, to clean the hole. Do not allow solder to cover the hole since new component leads may then push the pad away from the board.

i. To install a new component, straighten and shape the leads. Insert the component into the proper holes. Bend the leads at the conductor side of the circuit board so that they fall over the pad and extend over the foil of the incoming conductor path. Cut the bent lead approximately 2.5 mm (3/32 inch) from the hole. Clip a heat sink to the component lead at the body of the component. Heat the lead and the pad with a soldering iron and use fresh solder (60/40) as required to cover the lead and form a meniscus over the hole to ensure a good electrical connection.

j. After either removing or inserting a component, clean excess flux from the connection and surrounding area. Use TF Freon spray cleaner, such as Miller Stevenson Chemical Co., Type MS-180 (Ballantine P/N 80-10004-0A), low air pressure (5 to 20 PSIG), and a humidity seal spray, such as Humiseal, Columbia Technical Corp., Type 1B15 (Ballantine P/N 80-10005-0A), to seal the board and protect it against humidity. To avoid unwanted leakage, which may affect performance if the instrument is exposed to high humidity, do not touch the cleaned board or handle the components excessively.

CAUTION

Be extremely careful when cleaning the multiplier coils and adjacent components. Never bend the coils. Distorted coils and transformers may drastically affect the functions, calibration, and performance of the instrument.

k. Do not permit water or solvents to get into switches, connectors, or sockets. Avoid using corrosive cleaners which may damage metal or plastic parts.

SECTION VII

ILLUSTRATED PARTS BREAKDOWN

The replacement parts listed are available from the vendors listed or from Ballantine Laboratories. Your local Ballantine Field Engineering Representative may also carry a stock of parts and can assist you. If pricing quotations are required for parts and or repairs your local representative will give the most rapid service or you may contact the Ballantine Factory directly.

When ordering replacement parts always give the following information:

a) Instrument Model number
b) Serial number
c) Ballantine Part number
d) Schematic Symbol number
e) Identification and description of the part

Ballantine will do its best to improve the instrument and make changes in style of components and replacement parts. Replacement parts may differ in appearance from those found in your instrument but are always equal or superior in performance. Where necessary minor mechanical modifications may be required in the replacement of the components.

Parts are generally available locally for most replacements. The parts list calls out the recommended vendors where applicable.

The instrument may substitute alternate components but the use of parts specified in this parts list is recommended. A part similar to the part initially installed at the factory may be used, i.e., a 5% composition resistor may be replaced with a similar part or a 5% film resistor or the preferred 1% metal film resistor. Use of the preferred component will always simplify calibration and speed repairs.

Any selected component is generally identified in this manual and may be replaced with a similarly valued part unless reselection is required due to replacement or change of its related part. The schematics and calibration procedures identify selected components and replacement procedures.

The Manufacturer Code is taken from Federal Supply Code Cataloging Handbooks H4-1, H4-2, and H4-3. Ballantine Code is 50423.

The following parts coding are used:

CVC	Capacitor, Variable, Ceramic
CCT	Capacitor, Ceramic, Tubular
CFP	Capacitor, Fixed, Plastic
CCD	Capacitor, Ceramic, Disc
CYF	Capacitor, Mylar, Foil
CMD	Capacitor, Mica, Dipped
CMM	Capacitor, Mica, Molded
CEA	Capacitor, Electrolytic, Aluminum
CET	Capacitor, Electrolytic, Tantalum
DGP	Diode, General Purpose
DZG	Diode, Zener, General Purpose
DRP	Diode, Bridge, Power
FLT	Filter
ICP	Integrated Circuit
TRQ	Transistor
RFF	Resistor, Fixed, Film
RFC	Resistor, Fixed, Composition
RVC	Resistor, Variable, Composition
RFW	Resistor, Fixed, Wirewound
SWC	Switch
LMP	Lamp
TRX	Transformer

Resistors may generally be replaced by Corning Electronics (CCW) type N-55, N-60 and C-32. Allen Bradley carbon composition resistors type EB may also be used but should generally be avoided (except for emergency replacements) in favor of the preferred part listed in this parts list.

MODEL 6130A, EXPLODED VIEW, PARTS LIST

INDEX NO.	BALLANTINE P/N	DESCRIPTION	QTY.
1	44-10038-1	Bail & 2 Front Feet	1
2	44-10036-0	Rear Feet	2
3	69-10004-0	Latch, Cover (Black)	8
4	51-10060-1	Cover, Top	1
5	51-10059-1	Cover, Bottom	1
6	-	Not Used	-
7	-	Not Used	-
8	-	Not Used	-
9	32-10002-1	Plate, Nameplate	1
10	40-10040-0	CAP, Knob 28mm (Gray)	1
11	40-10020-0	KNB, 28mm 1/4 Shaft (Black)	1
12	40-10039-0	CAP, 14.5mm (Gray)	3
13	40-10038-0	KNB, 14.5mm 1/8 Shaft (Black)	3
14	05-10060-0	Green LED	1
15	25-10001-0	Toggle Switch	1
16	31-03379-0	Connector	3
17	-	Terminal Lug	3
18	38-10180-1	Panel, Front	1
19	66-10010-0	Handle, Black (Side)	1
20	-	Screw	2
21	89-10496-1	Switch Assy.	1
22	-	Nut	1
23	89-11238-1	Main Board Assy.	1
24	-	Screw	2
25	-	Not Used	-
26	89-10305-1	Panel, Rear	1
27	-	Screw	4
28	-	Not Used	-
29	36-10015-1	Frame Assy.	2
30	-	Screw	4
31	37-10012-1	Plate, Side Strips	1
32	37-10031-1	Plate, Side Handle	1
33	35-10037-1	Support, Side	2
34	33-10000-0	Line Cord	1

PARTS LIST, MODEL 6130A
MAIN BOARD ASSEMBLY (89–11238–1) – CONT'D

SCHEMATIC REF.	BALLANTINE PART NO.	DESCRIPTION	MFR. CODE	MFR. PART NUMBER
R. 410	12-12132-0A	RFF 21.5 250.0MW F+- 1%	016299	RN55D 21R5 F
R. 411	12-12100-0A	RFF 10.0 250.0MW F+- 1%	016299	RN55D 10R0 F
R. 412	12-12464-0A	RFF 46.4 K 250.0MW F+- 1%	016299	CGW RN55D 4642 F
R. 413	12-12132-0A	RFF 21.5 250.0MW F+- 1%	016299	RN55D 21R5 F
R. 414	12-12100-0A	RFF 10.0 250.0MW F+- 1%	016299	RN55D 10R0 F
R. 415	12-12168-0A	RFF 51.1 250.0MW F+- 1%	016299	RN55D 51R1 F
R. 416	12-12364-0A	RFF 4.64K 250.0MW F+- 1%	016299	CGW RN55D 4641 F
R. 417	12-12257-0A	RFF 392.0 250 MW F+-1%	016299	CGW RN55D 3920 F
R. 418	12-12132-0A	RFF 21.5 250.0MW F+- 1%	016299	RN55D 21R5 F
R. 419	12-12100-0A	RFF 10.0 250.0MW F+- 1%	016299	RN55D 10R0 F
R. 420	12-12600-0A	RFF 1.00M 500 MW F+-1%	016299	CGW RN60D 1004 F
R. 421	12-12446-0A	RFF 30.1 K 250.0MW F+- 1%	016299	CGW RN55D 3012 F
R. 422	12-12168-0A	RFF 51.1 250.0MW F+- 1%	016299	RN55D 51R1 F
R. 424	12-12117-0A	RFF 15.0 250.0MW F+- 1%	016299	RN55D 15R0 F
S. . 11	25-10099-1A	SWC 6130A HI FREQ SBL PC MT	050423	BLI
S. . 12	25-10172-1A	SWC 6130B MULTIPLIER	050423	BLI
S. . 13	25-10101-1A	SWC 6130A TRIG PERIOD PC MT	050423	BLI
S. 301	25-10062-1A	SWC SLIDE PC RT ANGLE DPDT	050423	BLI
U. . . 1	24-10153-0A	ICP UA7805 5V REG.	007263	FAIRCHILD UA7805UC
U. . . 2	24-10051-0A	ICP 78M12C 12 VOLT REG 1/2A TO	007263	FAIRCHILD UA78M12UC OR EQUIV
U. . 10	24-10003-0A	TCD SN7490N	001295	TEXAS INSTRUMENT SN7490AN
U. . 11	24-10003-0A	TCD SN7490N	001295	TEXAS INSTRUMENT SN7490AN
U. . 12	24-10003-0A	TCD SN7490N	001295	TEXAS INSTRUMENT SN7490AN
U. . 13	24-10003-0A	TCD SN7490N	001295	TEXAS INSTRUMENT SN7490AN
U. . 14	24-10003-0A	TCD SN7490N	001295	TEXAS INSTRUMENT SN7490AN
U. . 15	24-10003-0A	TCD SN7490N	001295	TEXAS INSTRUMENT SN7490AN
U. . 16	24-10003-0A	TCD SN7490N	001295	TEXAS INSTRUMENT SN7490AN
U. . 17	24-10002-0A	TCD SN7474N	001295	TEXAS INSTRUMENT
U. 100	24-10003-0A	TCD SN7490N	001295	TEXAS INSTRUMENT SN7490AN
U. 301	24-10041-0A	ICP LIN DUAL OD AMP 10116	004713	MOTOROLA MC10116P
XY. . 1	42-10000-1A	OVN OVEN SEMI CON TO-5 20V	050423	BLI

REFERENCE DESIGNATOR LOCATION

REFERENCE DESIGNATOR	INDEX NO.	REFERENCE DESIGNATOR	INDEX NO.	REFERENCE DESIGNATOR	INDEX NO.
L300	37	R209	65	R404	80
Q100	44	R210	66	R405	72
Q101	44	R211	63	R406	72
Q200	44	R212	53	R407	72
Q201	44	R213	60	R408	81
Q202	45	R214	67	R409	63
Q203	47	R215	63	R410	80
Q204	45	R216	63	R411	72
Q301	48	R217	66	R412	82
Q302	48	R218	66	R413	80
Q303	49	R219	63	R414	72
Q304	49	R301	69	R415	73
Q305	49	R302	70	R416	83
Q400	45	R303	69	R417	59
Q401	45	R304	69	R418	80
Q402	46	R305	71	R419	72
Q403	46	R306	71	R420	84
Q404	45	R307	71	R421	85
Q405	46	R308	71	R422	73
Q406	46	R309	72	R424	86
Q407	46	R310	63	S11	87
R1	66	R311	71	S12	88
R100	52	R312	76	S13	89
R101	52	R313	71	S301	90
R102	53	R314	63	U1	94
R103	54	R315	73	U2	95
R104	55	R316	70	U10	96
R105	56	R317	74	U11	96
R106	57	R318	75	U12	96
R107	58	R319	76	U13	96
R108	58	R320	70	U14	96
R109	63	R321	69	U15	96
R200	59	R323	80	U16	96
R201	60	R324	61	U17	97
R202	61	R400	72	U100	96
R203	62	R401	78	U301	99
R204	63	R402	69	XY1	101
R208	64	R403	79	Y1	102

INDEX NO.'s WITHOUT REFERENCE DESIGNATORS

INDEX NO.	DESCRIPTION
35	Screw, Nut, Washer
98	Mounting Pad (Ballantine P/N: 48-10006-0)
100	Mounting Pad (Ballantine P/N: 48-10007-0)

PARTS LIST, MODEL 6130A
REAR PANEL ASSEMBLY (89-10305-1)

SCHEMATIC REF.	BALLANTINE PART NO.	DESCRIPTION	MFR. CODE	MFR. PART NUMBER
F..10	19-03411-0A	FUS .5AMP SLOBLOW TYPE 3AG	075915	LITTELFUSE 313.500
J...4	31-03379-0A	CON UG-1094/U BNC, DAGE	029587	STATE ELECT. PARTS
J...5	31-10166-0A	REC UNIVERSAL IEEE FUSED REC	005245	CORCOM VS 7F FILTERED 6J4

REFERENCE DESIGNATOR LOCATION

REFERENCE DESIGNATOR	INDEX NO.	REFERENCE DESIGNATOR	INDEX NO.	REFERENCE DESIGNATOR	INDEX NO.
F10	1	J4	2	J5	4

INDEX NO.'s WITHOUT REFERENCE DESIGNATORS

INDEX NO.	DESCRIPTION
3	Terminal, Lug
5	Transformer, Power (Ballantine P/N: 21-10028-1)
6	Screw, Washer, Nut
7	Panel, Rear (Ballantine P/N: 38-10077-1)

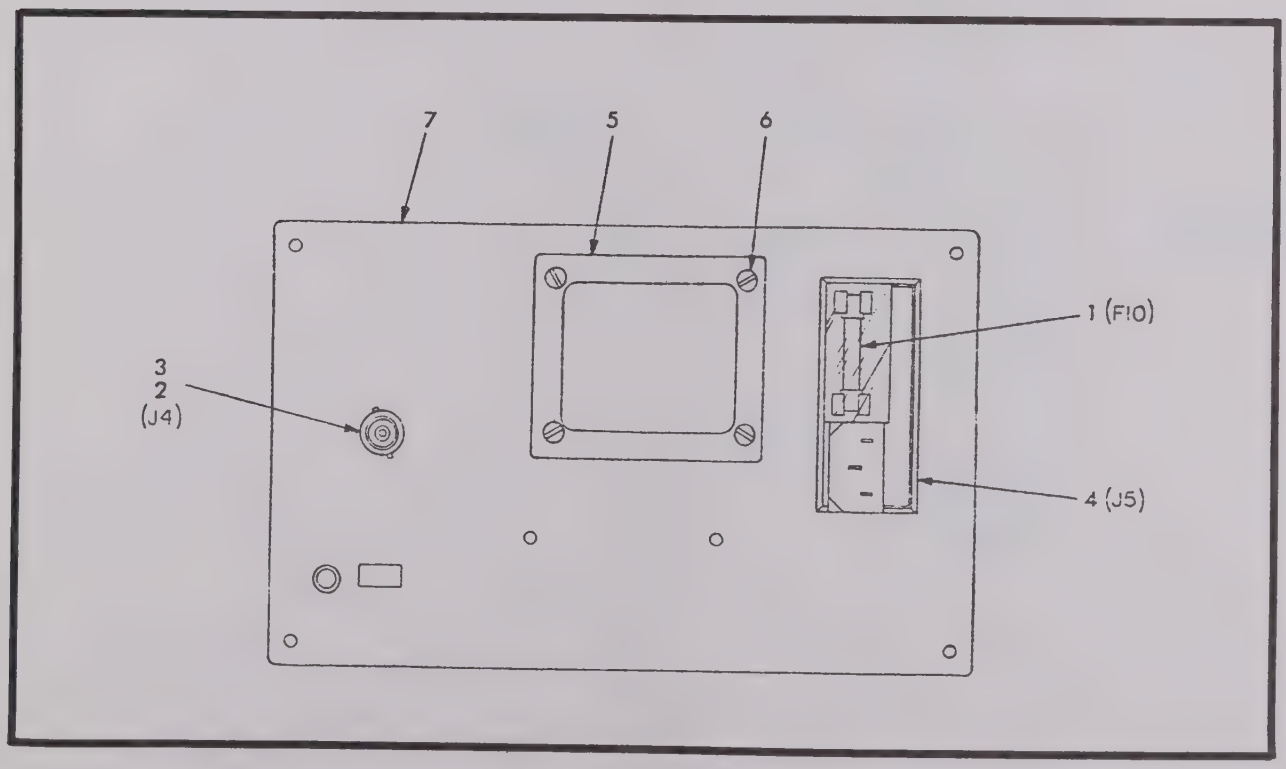


Figure 7-4. Model 6130A, Rear Panel Assembly, Component Layout Diagram

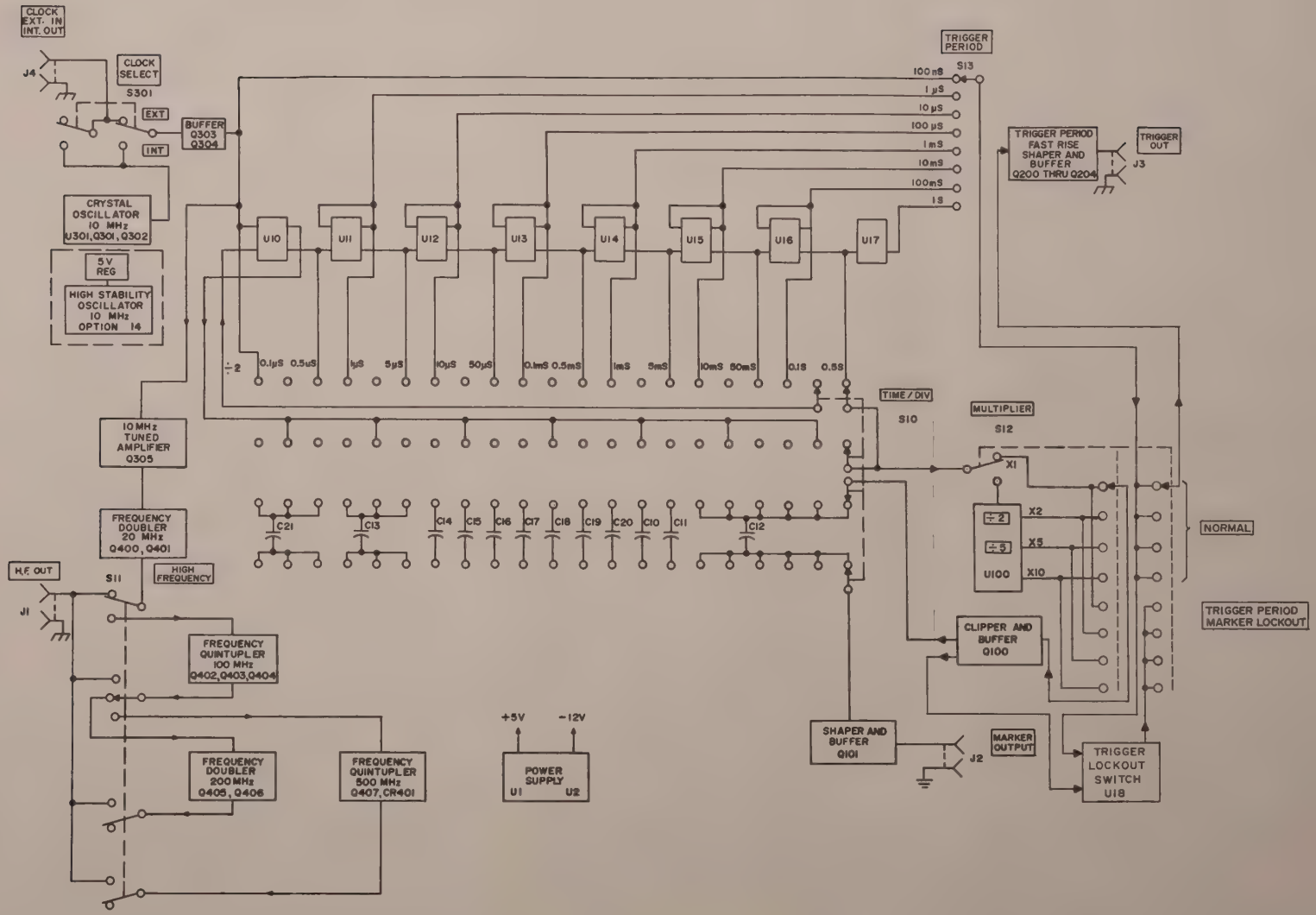


Figure 4-1. 6130A Time Mark Generator, Block Diagram

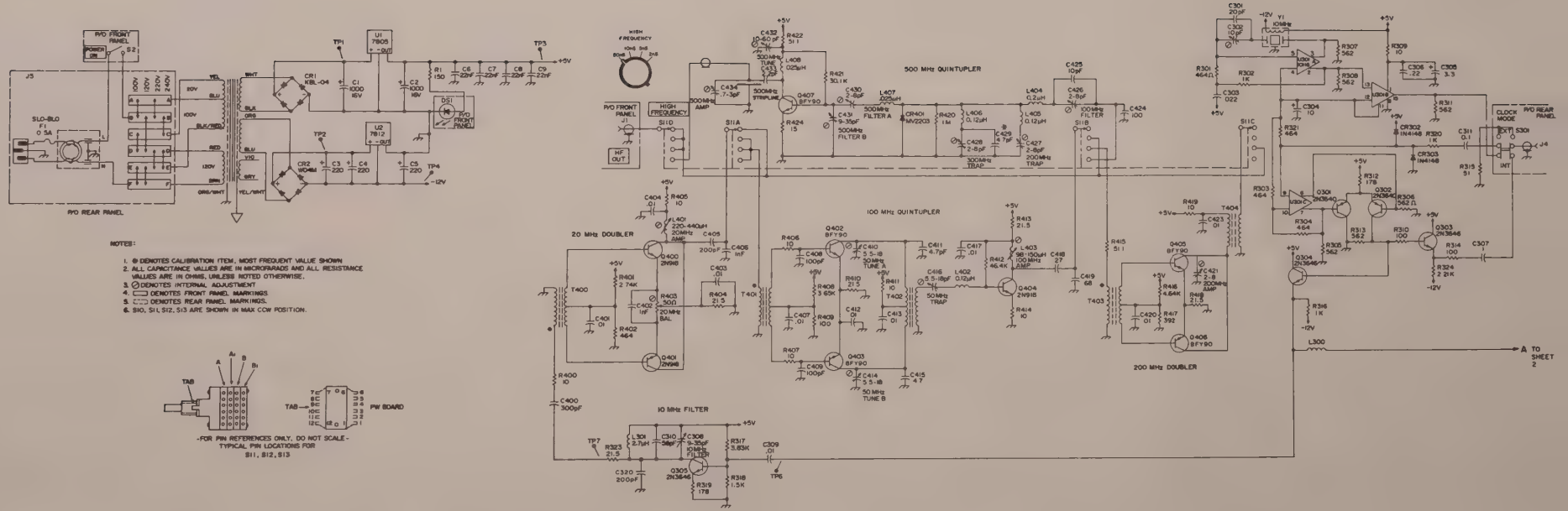


Figure 6-1. Model 6130A Time Mark Generator, Schematic Diagram (Sheet 1 of 2)

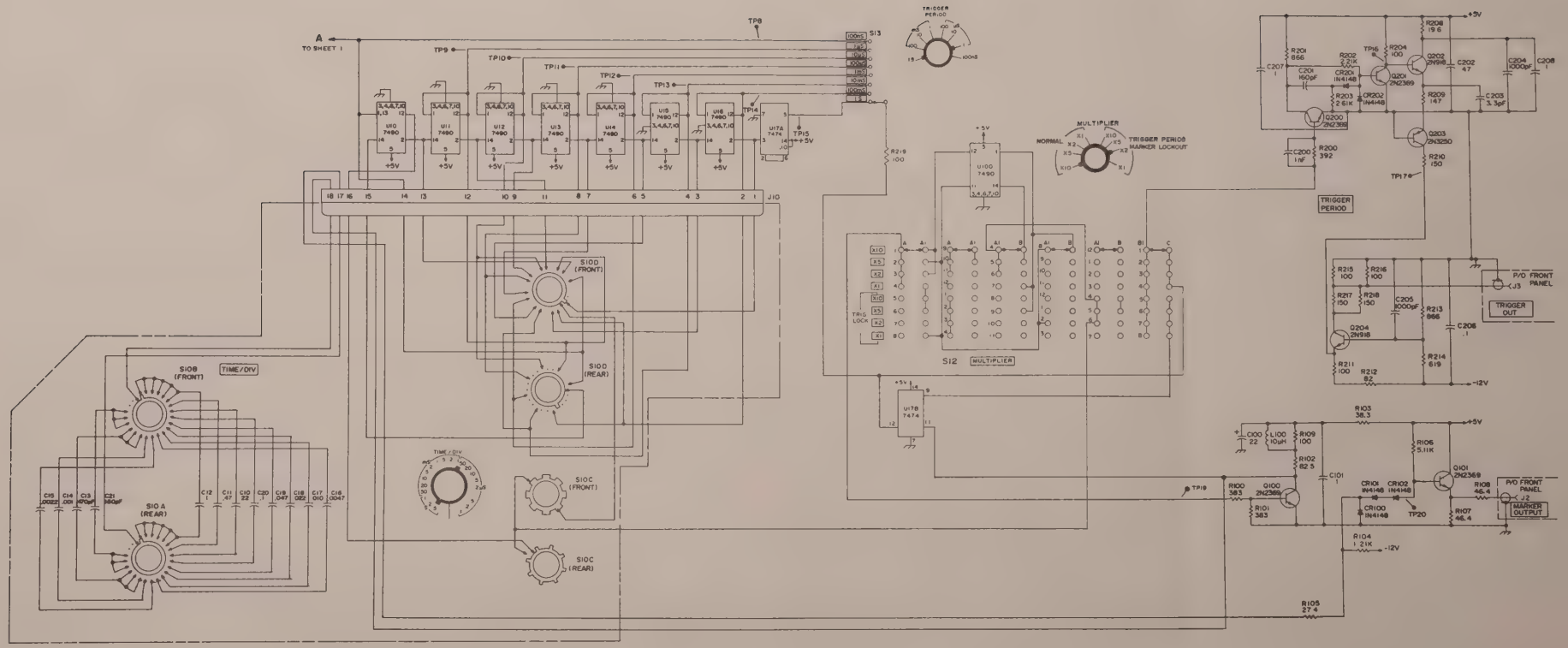


Figure 6-1. Model 6130A Time Mark Generator, Schematic Diagram (Sheet 2 of 2)

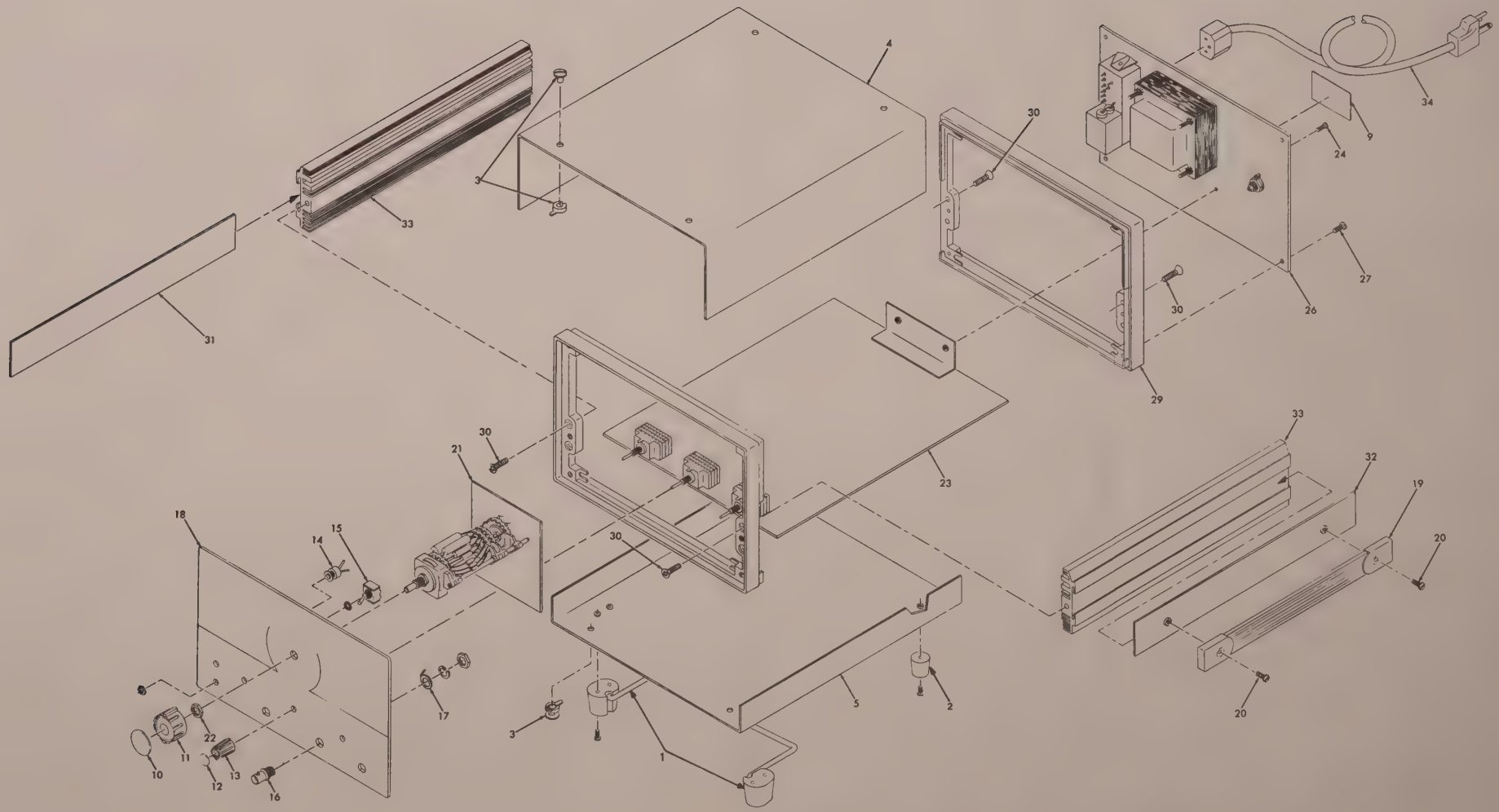


Figure 7-1. Model 6130A, Exploded View

PARTS LIST, MODEL 6130A
MAIN BOARD ASSEMBLY (89-11238-1)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR. PART NUMBER
C...1	07-07833-0A	CEA1000.0UF 16.0 VT	073445	AMPEREX C437AR/E1000
C...2	07-10235-0A	CEA 100.0UF 25.0 VT	073445	AMPREX ET101X025A5
C...3	07-10252-0A	CEA 330.0UF 63.0 V -10+50%	073445	AMPEREC ET331X063AD3
C...4	07-10252-0A	CEA 330.0UF 63.0 V -10+50%	073445	AMPEREC ET331X063AD3
C...5	07-10235-0A	CEA 100.0UF 25.0 VT	073445	AMPREX ET101X025A5
C...6	07-10120-0A	CCD 22.0NF 25.0 VM	071590	CENTRLB UK25223 OR EQUIV
C...7	07-10120-0A	CCD 22.0NF 25.0 VM	071590	CENTRLB UK25223 OR EQUIV
C...8	07-10120-0A	CCD 22.0NF 25.0 VM	071590	CENTRLB UK25223 OR EQUIV
C.100	07-09565-0A	CET 22 UF 20 V	056289	SPG TYP 196D 226C0020FR
C.101	07-10249-0A	CYM 1.0UF 100.0 VK MET MYL	080031	MEPCO 713A1KK105PK1018C
C.200	07-09561-0A	CCD 1 NF 1 KV K 10%	084171	ARC TYP CCB-102
C.201	07-10137-0A	CMD 160. PF 300. VJ	072136	ELMENCO DM15FD161J03
C.202	07-10116-0A	CCR 470.0NF 25.0 VM	056289	SPRAGUE 2C37Z5U474M050B
C.203	07-10081-0A	CCD 3.3PF 500. V	090201	RMC TYPE CG
C.204	07-09561-0A	CCD 1 NF 1 KV K 10%	084171	ARC TYP CCB-102
C.205	07-09561-0A	CCD 1 NF 1 KV K 10%	084171	ARC TYP CCB-102
C.206	07-10124-0A	CCR 100. NF 50. VM .375LEA	056289	SPRAGUE 2C37Z5U104M050B
C.207	07-10112-0A	CCC 100.0NF 50.0 V CHIP	071590	CENTRLB W005FH104M
C.208	07-10112-0A	CCC 100.0NF 50.0 V CHIP	071590	CENTRLB W005FH104M
C.301	07-10437-0A	CMD 18.0PF 300.0 VD	084171	ARCO CM05CD180D03 OR EQUV
C.302	07-09208-0A	CVC 2.0-15PF TRIMMER	010339	JACKSON BROS. 3890/HPC 2-15PF
C.303	07-10120-0A	CCD 22.0NF 25.0 VM	071590	CENTRLB UK25223 OR EQUIV
C.304	07-10053-0A	CET 10.0UF 35.0V M	090201	MALLORY TDC 106M035WLF
C.305	07-10187-0A	CET 3.3UF 10.0 VM DIP TAN	056289	SPRAGUE 196D335X0015
C.306	07-10120-0A	CCD 22 ONF 25 0 VM	071590	CENTRLB UK25223 OR EQUIV
C.307	07-10124-0A	CCR 100. NF 50. VM .375LEA	056289	SPRAGUE 2C37Z5U104M050B
C.308	07-10453-0A	CVC9-35.0PF 250.0 V	072982	ERIE 538-011D-9-35
C.309	07-09576-0A	CCD 10.0NF 150.0 VT+-40%	071590	CTL TYP DDM 103
C.310	07-02289-0A	CMD 56 PF 300 V T	084171	ARCO DM-15-560F SILVERED
C.311	07-10124-0A	CCR 100. NF 50. VM .375LEA	056289	SPRAGUE 2C37Z5U104M050B
C.320	07-02257-0A	CMD 200 PF 500 V K 10%	084171	ARCO TYPE DM-15-201-K
C.400	07-02280-0A	CMB 300 PF 500 V K 10%	084171	ARCO TYPE DM-15-301-K
C.401	07-09576-0A	CCD 10.0NF 150.0 VT+-40%	071590	CTL TYP DDM 103
C.402	07-09561-0A	CCD 1 NF 1 KV K 10%	084171	ARC TYP CCB-102
C.403	07-09576-0A	CCD 10.0NF 150.0 VT+-40%	071590	CTL TYP DDM 103
C.404	07-09576-0A	CCD 10.0NF 150.0 VT+-40%	071590	CTL TYP DDM 103
C.405	07-02257-0A	CMD 200 PF 500 V K 10%	084171	ARCO TYPE DM-15-201-K
C.406	07-09561-0A	CCD 1 NF 1 KV K 10%	084171	ARC TYP CCB-102
C.407	07-09576-0A	CCD 10.0NF 150.0 VT+-40%	071590	CTL TYP DDM 103
C.408	07-09552-0A	CCD 100 PF 1 KV K 10%	084171	ARC TYP CCD-101
C.409	07-09552-0A	CCD 100 PF 1 KV K 10%	084171	ARC TYP CCD-101
C.410	07-02448-0A	CVC 5.5-18PF 350V	072982	ERIE NPO STYLE 538-011
C.411	07-10006-0A	CCD 4.7PF 500 V DISC	090201	RMC TYPE CG
C.412	07-09576-0A	CCD 10.0NF 150.0 VT+-40%	071590	CTL TYP DDM 103
C.413	07-09576-0A	CCD 10.0NF 150.0 VT+-40%	071590	CTL TYP DDM 103
C.414	07-02448-0A	CVC 5.5-18PF 350V	072982	ERIE NPO STYLE 538-011
C.415	07-10006-0A	CCD 4.7PF 500 V DISC	090201	RMC TYPE CG
C.416	07-02448-0A	CVC 5.5-18PF 350V	072982	ERIE NPO STYLE 538-011
C.417	07-09576-0A	CCD 10.0NF 150.0 VT+-40%	071590	CTL TYP DDM 103
C.418	07-10199-0A	CCD 27.0PF 1.0KVJ NPO	056289	SPRAG C030B1029270J OR EQ
C.419	07-20010-0A	CCD 68.0PF 250.0 VK+-10%	071590	CTL DD-680
C.420	07-09576-0A	CCD 10.0NF 150.0 VT+-40%	071590	CTL TYP DDM 103
C.421	07-02449-0A	CVC 2.0-8PF 350.0 V	072982	ERIE DV11P8BA
C.423	07-09576-0A	CCD 10.0NF 150.0 VT+-40%	071590	CTL TYP DDM 103
C.424	07-09552-0A	CCD 100 PF 1 KV K 10%	084171	ARC TYP CCD-101
C.425	07-09551-0A	CCD 10.0PF 1.0 KVJ NPO	056289	ARC TYP CCD-100
C.426	07-02449-0A	CVC 2.0-8PF 350.0 V	072982	ERIE DV11P8BA
C.427	07-02449-0A	CVC 2.0-8PF 350.0 V	072982	ERIE DV11P8BA
C.428	07-02449-0A	CVC 2.0-8PF 350.0 V	072982	ERIE DV11P8BA
C.429	07-10006-0A	CCD 4.7PF 500 V DISC	090201	RMC TYPE CG
C.430	07-02449-0A	CVC 2.0-8PF 350.0 V	072982	ERIE DV11P8BA
C.431	07-10453-0A	CVC9-35.0PF 250.0 V	072982	ERIE 538-011D-9-35
C.432	07-10360-0A	CVD 10-60 350.0 V N750	052763	STET-TRUSH IDSTRIK022
C.433	07-02595-0A	CCT 2.2PF K+-10%	095121	QUALITY COMPONENTS TP QC
C.434	07-10595-0A	CVC .6/3.5PF 160V	052763	STETTNER ELEC. 313613-140
CR..1	05-10062-0A	DGP KBL04 400 2.5A	011711	GI BRIDGE RCT
CR..2	05-10006-0A	DGP WO4M 4000 1.5A	005828	GIC
CR100	05-07920-0A	DGP 1N4148 75 10M	007263	FCH SI D035
CR101	05-07920-0A	DGP 1N4148 75 10M	007263	FCH SI D035
CR102	05-07920-0A	DGP 1N4148 75 10M	007263	FCH SI D035
CR201	05-07920-0A	DGP 1N4148 75 10M	007263	FCH SI D035
CR202	05-07920-0A	DGP 1N4148 75 10M	007263	FCH SI D035
CR302	05-07920-0A	DGP 1N4148 75 10M	007263	FCH SI D035
CR303	05-07920-0A	DGP 1N4148 75 10M	007263	FCH SI D035
CR401	05-10055-0A	DVC MV2203 25 10PF .28	004713	MOT SI VOLT VAR CAP
J..10	31-10108-0A	CDN 18 PIN SINGLE ROW PC MT	091662	ELCO 00-6007-018-938-018
L.100	03-10021-0A	CRF 10UH INDUCTOR,PEAKING	083125	NYTRONICS DD-10.0

PARTS LIST, MODEL 6130A
MAIN BOARD ASSEMBLY (89-11238-1) — CONT'D

SCHEMATIC REF.	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
L.301	03-10033-0A	CIL 2.7 UH RF MOLDED	083125	NYTRONICS 75008-33
L.401	03-10041-0A	CLV 352-431 UH PC MT VAR	071729	CTC 556-7105-B-00-00
L.402	03-10043-1A	CIL .12 UH AIR COIL	050423	BLI
L.403	03-10042-0A	CLV .90-.110 UH PC MT VAR	071729	CTC 556-7105-1-00-00
L.404	03-10044-1B	CIL .20 UH AIR COIL	050423	BLI
L.405	03-10043-1A	CIL .12 UH AIR COIL	050423	BLI
L.406	03-10043-1A	CIL .12 UH AIR COIL	050423	BLI
L.407	03-10045-1A	CIL .025 UH AIR COIL	050423	BLI
L.408	03-10045-1A	CIL .025 UH AIR COIL	050423	BLI
T.400	20-10069-0A	TRX RF 350MHZ 50 OHM PR1 1/4	013542	MINI-CKTS LAB T4-1
T.401	20-10069-0A	TRX RF 350MHZ 50 OHM PR1 1/4	013542	MINI-CKTS LAB T4-1
T.402	20-10025-1B	TRX RF AIR 6130A QUINTUPLER	050423	BLI
T.403	20-10069-0A	TRX RF 350MHZ 50 OHM PR1 1/4	013542	MINI-CKTS LAB T4-1
T.404	20-10026-1A	TRX RF AIR 6130A 200 MHZ	050423	BLI

REFERENCE DESIGNATOR LOCATION

REFERENCE DESIGNATOR	INDEX NO.	REFERENCE DESIGNATOR	INDEX NO.	REFERENCE DESIGNATOR	INDEX NO.
C1	1	C400	109	C432	110
C2	2	C401	18	C433	28
C3	3	C402	7	C434	29
C4	3	C403	18	CR1	30
C5	2	C404	18	CR2	31
C6	4	C405	20	CR100	32
C7	4	C406	7	CR101	32
C8	4	C407	18	CR102	32
C100	5	C408	21	CR201	32
C101	6	C409	21	CR202	32
C200	7	C410	22	CR302	32
C201	8	C411	23	CR303	32
C202	9	C412	18	CR401	33
C203	10	C413	18	J10	34
C204	7	C414	22	L100	36
C205	7	C415	23	L301	38
C206	11	C416	22	L401	39
C207	12	C417	18	L402	40
C208	12	C418	25	L403	41
C301	13	C419	26	L404	42
C302	14	C420	18	L405	40
C303	4	C421	24	L406	40
C304	15	C423	18	L407	43
C305	16	C424	21	L408	43
C306	4	C425	27	T400	91
C307	11	C426	24	T401	91
C308	17	C427	24	T402	92
C309	18	C428	24	T403	91
C310	19	C429	23	T404	93
C311	11	C430	24		
C320	20	C431	17		

INDEX NO.'s WITHOUT REFERENCE DESIGNATORS

INDEX NO.	DESCRIPTION
104	Bracket, Heatsink (Ballantine P/N: 35-10089-1)
105	Screw, Washer, Nut
106	Screw, Washer, Nut
108	Printed Wiring Board (Ballantine P/N 55-10168-1)

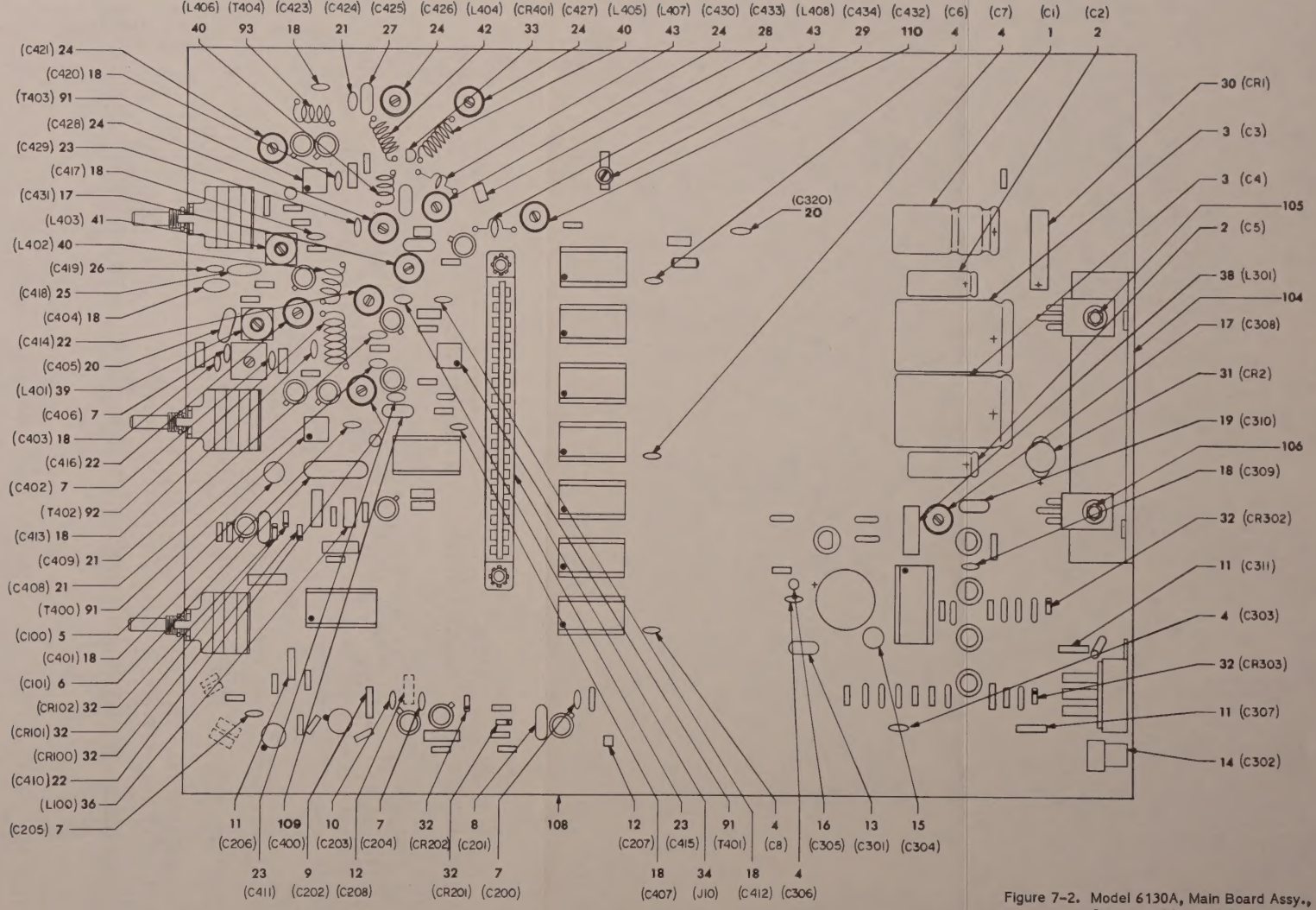


Figure 7-2. Model 6130A, Main Board Assy., Component Layout Diagram (Sheet 1 of 2)

PARTS LIST, MODEL 6130A
MAIN BOARD ASSEMBLY (89-11238-1) - CONT'D

SCHEMATIC REF.	BALLANTINE PART NO.	DESCRIPTION	MFR. CODE	MFR. PART NUMBER
L. 300	03-10002-0A	CIL .47 UH MOLDED WEEDUCTOR	083125	NYTRONICS DD-0.47 OR EQUV
Q. 100	10-10001-0A	TRG 2N2369 NPN 1 15 MTO-18	004713	MOT 1.2 500M 20
Q. 101	10-10001-0A	TRG 2N2369 NPN 1 15 MTO-18	004713	MOT 1.2 500M 20
Q. 200	10-10001-0A	TRG 2N2369 NPN 1 15 MTO-18	004713	MOT 1.2 500M 20
Q. 201	10-10001-0A	TRG 2N2369 NPN 1 15 MTO-18	004713	MOT 1.2 500M 20
Q. 202	10-08055-0A	TRG 2N918 PNP 1 15 PTO-18	004713	MOTOROLA 2N918
Q. 203	10-10017-0A	TRG 2N3250 PNP 1 40 MTO-18	004713	MOT 1.2 250M 50
Q. 204	10-08055-0A	TRG 2N918 PNP 1 15 PTO-18	004713	MOTOROLA 2N918
Q. 301	10-07934-0A	TRG 2N3640 PNP 1 12 TO-106	007263	FCH .500 300M 30
Q. 302	10-07934-0A	TRG 2N3640 PNP 1 12 TO-106	007263	FCH .500 300M 30
Q. 303	10-10033-0A	TRG 2N3646 NPN 1 15 PTO-92	004713	FCH .5 350M 25
Q. 304	10-10033-0A	TRG 2N3646 NPN 1 15 PTO-92	004713	FCH .5 350M 25
Q. 305	10-10033-0A	TRG 2N3646 NPN 1 15 PTO-92	004713	FCH .5 350M 25
Q. 400	10-08055-0A	TRG 2N918 PNP 1 15 PTO-18	004713	MOTOROLA 2N918
Q. 401	10-08055-0A	TRG 2N918 PNP 1 15 PTO-18	004713	MOTOROLA 2N918
Q. 402	10-10157-0A	TRG BFY90 NPN 1 15V S TO 72	050423	SGS ATES
Q. 403	10-10157-0A	TRG BFY90 NPN 1 15V S TO 72	050423	SGS ATES
Q. 404	10-08055-0A	TRG 2N918 PNP 1 15 PTO-18	004713	MOTOROLA 2N918
Q. 405	10-10157-0A	TRG BFY90 NPN 1 15V S TO 72	050423	SGS ATES
Q. 406	10-10157-0A	TRG BFY90 NPN 1 15V S TO 72	050423	SGS ATES
Q. 407	10-10157-0A	TRG BFY90 NPN 1 15V S TO 72	050423	SGS ATES
R...1	12-12217-0A	RFF 150.0 250.0MW F+- 1%	016299	CGW RN55D 1500 F
R. 100	12-12256-0A	RFF 383.0 250 MW F+-1%	016299	CGW RN55D 3830 F
R. 101	12-12256-0A	RFF 383.0 250 MW F+-1%	016299	CGW RN55D 3830 F
R. 102	12-12188-0A	RFF 82.5 250.0MW F+- 1%	016299	RN55D 82R5 F
R. 103	12-12156-0A	RFF 38.3 250.0MW F+- 1%	016299	RN55D 38R3 F
R. 104	12-12308-0A	RFF 1.21K 250 MW F+-1%	016299	CGW RN55D 1211 F
R. 105	12-12142-0A	RFF 27.4 250.0MW F+- 1%	016299	RN55D 27R4 F
R. 106	12-12368-0A	RFF 5.11K 250.0MW F+- 1%	016299	CGW RN55D 5111 F
R. 107	12-12164-0A	RFF 46.4 250.0MW F+- 1%	016299	RN55D 46R4 F
R. 108	12-12164-0A	RFF 46.4 250.0MW F+- 1%	016299	RN55D 46R4 F
R. 109	12-12200-0A	RFF 100.0 250.0MW F+- 1%	016299	CGW RN55D 1000 F
R. 200	12-12257-0A	RFF 392.0 250 MW F+-1%	016299	CGW RN55D 3920 F
R. 201	12-12290-0A	RFF 866.0 250 MW F+-1%	016299	CGW RN55D 8660 F
R. 202	12-12333-0A	RFF 2.21K 250.0MW F+- 1%	016299	CGW RN55D 2211 F
R. 203	12-12340-0A	RFF 2.61K 250.0MW F+- 1%	016299	CGW RN55D 2611 F
R. 204	12-12200-0A	RFF 100.0 250.0MW F+- 1%	016299	CGW RN55D 1000 F
R. 208	12-12128-0A	RFF 19.6 250.0MW F+- 1%	016299	RN55D 19R6 F
R. 209	12-12216-0A	RFF 147.0 250.0MW F+- 1%	016299	CGW RN55D 1470 F
R. 210	12-12217-0A	RFF 150.0 250.0MW F+- 1%	016299	CGW RN55D 1500 F
R. 211	12-12200-0A	RFF 100.0 250.0MW F+- 1%	016299	CGW RN55D 1000 F
R. 212	12-12188-0A	RFF 82.5 250.0MW F+- 1%	016299	RN55D 82R5 F
R. 213	12-12290-0A	RFF 866.0 250 MW F+-1%	016299	CGW RN55D 8660 F
R. 214	12-12276-0A	RFF 619.0 250 MW F+-1%	061299	CGW RN55D 6190 F
R. 215	12-12200-0A	RFF 100.0 250.0MW F+- 1%	016299	CGW RN55D 1000 F
R. 216	12-12200-0A	RFF 100.0 250.0MW F+- 1%	016299	CGW RN55D 1000 F
R. 217	12-12217-0A	RFF 150.0 250.0MW F+- 1%	016299	CGW RN55D 1500 F
R. 218	12-12217-0A	RFF 150.0 250.0MW F+- 1%	016299	CGW RN55D 1500 F
R. 219	12-12200-0A	RFF 100.0 250.0MW F+- 1%	016299	CGW RN55D 1000 F
R. 301	12-12264-0A	RFF 464.0 250 MW F+-1%	016299	CGW RN55D 4640 F
R. 302	12-12300-0A	RFF 1.0 K 250 MW F+-1%	016299	CGW RN55D 1001 F
R. 303	12-12264-0A	RFF 464.0 250 MW F+-1%	016299	CGW RN55D 4640 F
R. 304	12-12264-0A	RFF 464.0 250 MW F+-1%	016299	CGW RN55D 4640 F
R. 305	12-12272-0A	RFF 562.0 250 MW F+-1%	016299	CGW RN55D 5620 F
R. 306	12-12272-0A	RFF 562.0 250 MW F+-1%	016299	CGW RN55D 5620 F
R. 307	12-12272-0A	RFF 562.0 250 MW F+-1%	016299	CGW RN55D 5620 F
R. 308	12-12272-0A	RFF 562.0 250 MW F+-1%	016299	CGW RN55D 5620 F
R. 309	12-12100-0A	RFF 10.0 250.0MW F+- 1%	016299	RN55D 10R0 F
R. 310	12-12200-0A	RFF 100.0 250.0MW F+- 1%	016299	CGW RN55D 1000 F
R. 311	12-12272-0A	RFF 562.0 250 MW F+-1%	016299	CGW RN55D 5620 F
R. 312	12-12224-0A	RFF 178.0 250 MW F+-1%	016299	CGW RN55D 1780 F
R. 313	12-12272-0A	RFF 562.0 250 MW F+-1%	016299	CGW RN55D 5620 F
R. 314	12-12200-0A	RFF 100.0 250.0MW F+- 1%	016299	CGW RN55D 1000 F
R. 315	12-12168-0A	RFF 51.1 250.0MW F+- 1%	016299	RN55D 51R1 F
R. 316	12-12300-0A	RFF 1.0 K 250 MW F+-1%	016299	CGW RN55D 1001 F
R. 317	12-12356-0A	RFF 3.83K 250.0MW F+- 1%	016299	CGW RN55D 3831 F
R. 318	12-12317-0A	RFF 1.50K 250 MW F+-1%	016299	CGW RN55D 1501 F
R. 319	12-12224-0A	RFF 178.0 250 MW F+-1%	016299	CGW RN55D 1780 F
R. 320	12-12300-0A	RFF 1.0 K 250 MW F+-1%	016299	CGW RN55D 1001 F
R. 321	12-12264-0A	RFF 464.0 250 MW F+-1%	016299	CGW RN55D 4640 F
R. 323	12-12132-0A	RFF 21.5 250.0MW F+- 1%	016299	RN55D 21R5 F
R. 324	12-12333-0A	RFF 2.21K 250.0MW F+- 1%	016299	CGW RN55D 2211 F
R. 400	12-12100-0A	RFF 10.0 250.0MW F+- 1%	016299	RN55D 10R0 F
R. 401	12-12342-0A	RFF 2.74K 250.0MW F+- 1%	016299	CGW RN55D 2741 F
R. 402	12-12264-0A	RFF 464.0 250 MW F+-1%	016299	CGW RN55D 4640 F
R. 403	09-10095-0A	RVF 50.0 500.0MW M	073138	HELIPOT 72PM 50
R. 404	12-12132-0A	RFF 21.5 250.0MW F+- 1%	016299	RN55D 21R5 F
R. 405	12-12100-0A	RFF 10.0 250.0MW F+- 1%	016299	RN55D 10R0 F
R. 406	12-12100-0A	RFF 10.0 250.0MW F+- 1%	016299	RN55D 10R0 F
R. 407	12-12100-0A	RFF 10.0 250.0MW F+- 1%	016299	RN55D 10R0 F
R. 408	12-12354-0A	RFF 3.65K 250.0MW F+- 1%	016299	CGW RN55D 3651 F
R. 409	12-12200-0A	RFF 100.0 250.0MW F+- 1%	016299	CGW RN55D 1000 F

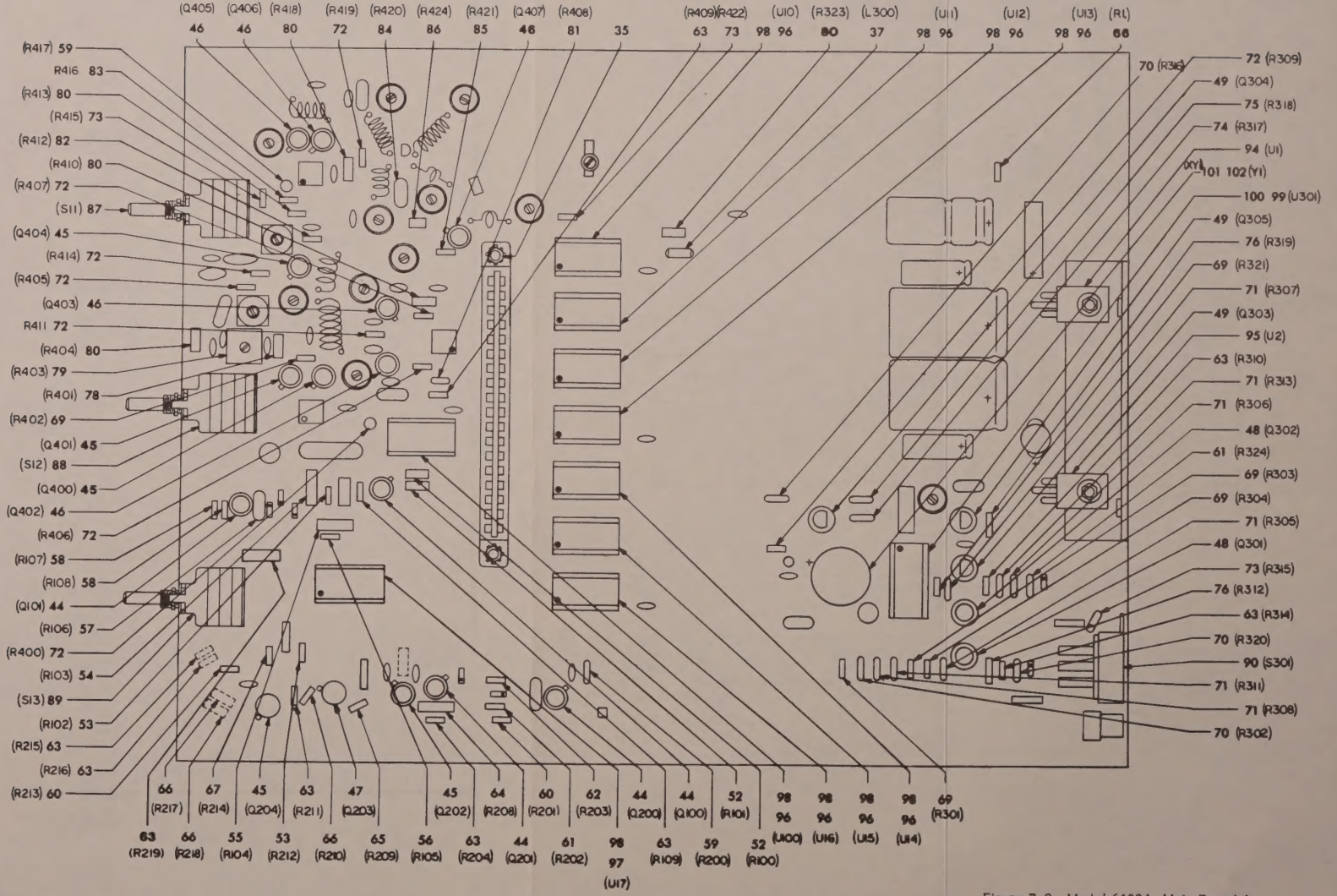


Figure 7-2. Model 6130A, Main Board Assy., Component Layout Diagram (Sheet 2 of 2)

PARTS LIST, MODEL 6130A
TIME/DIV SWITCH ASSEMBLY (89-10496-1)

SCHEMATIC REF.	BALLANTINE PART NO.	DESCRIPTION	MFR. CODE	MFR. PART NUMBER
C..10	07-02362-0A	CPF 220NF 200V VK 10%	056289	SPRAGUE TYPE 192P22492
C..11	07-10326-0A	CMD 470.0NF 80.0VK 10%	056289	CDE WMF1P47
C..12	07-08134-0A	CYM 1.0UF 50 V M 20%	084411	TRW TYPE X663F
C..13	07-02292-0A	CMD 470.0PF 300.0 FJ+- 5%	084171	ARCO DM-15-471-J
C..14	07-08119-0A	CMM 1.0NF 600.0 VK+-10%	056289	SPRAGUE 1.92P10294
C..15	07-02366-0A	CPF 22NF 200V VK 10%	056289	SPRAGUE TYPE 192P22292
C..16	07-08132-0A	CMM 4.7NF 80 V M 20%	056289	SPRAGUE 192P47Z9R8
C..17	07-02365-0A	CPF 10NF 200V VK 10%	056289	SPRAGUE TYPE 192P
C..18	07-02372-0A	CXF 22.0NF 200.0 VM+-20%	056289	REFER TO 07-02355-0A
C..19	07-08130-0A	CMM 47.0NF 200.0V M+-20%	056289	SPRAGUE 192P47392
C..20	07-08129-0A	CMM 100 NF 80 V M 20%	056289	SPRAGUE 192P1040R8
C..21	07-10137-0A	CMO 160. PF 300. VJ	072136	ELMENCO DM15FD161J03
S..10	29-10092-1E	SWC 21 POS 4DES MOD 6130 THE	050423	BLI

REFERENCE DESIGNATOR LOCATION

REFERENCE DESIGNATOR	INDEX NO.	REFERENCE DESIGNATOR	INDEX NO.	REFERENCE DESIGNATOR	INDEX NO.
C10	4	C15	10	C20	5
C11	3	C16	9	C21	13
C12	2	C17	8	S10	14
C13	12	C18	7		
C14	11	C19	6		

INDEX NO.'s WITHOUT REFERENCE DESIGNATORS

INDEX NO.	DESCRIPTION
1	Printed Wiring Board (Ballantine P/N: 55-10048-1)

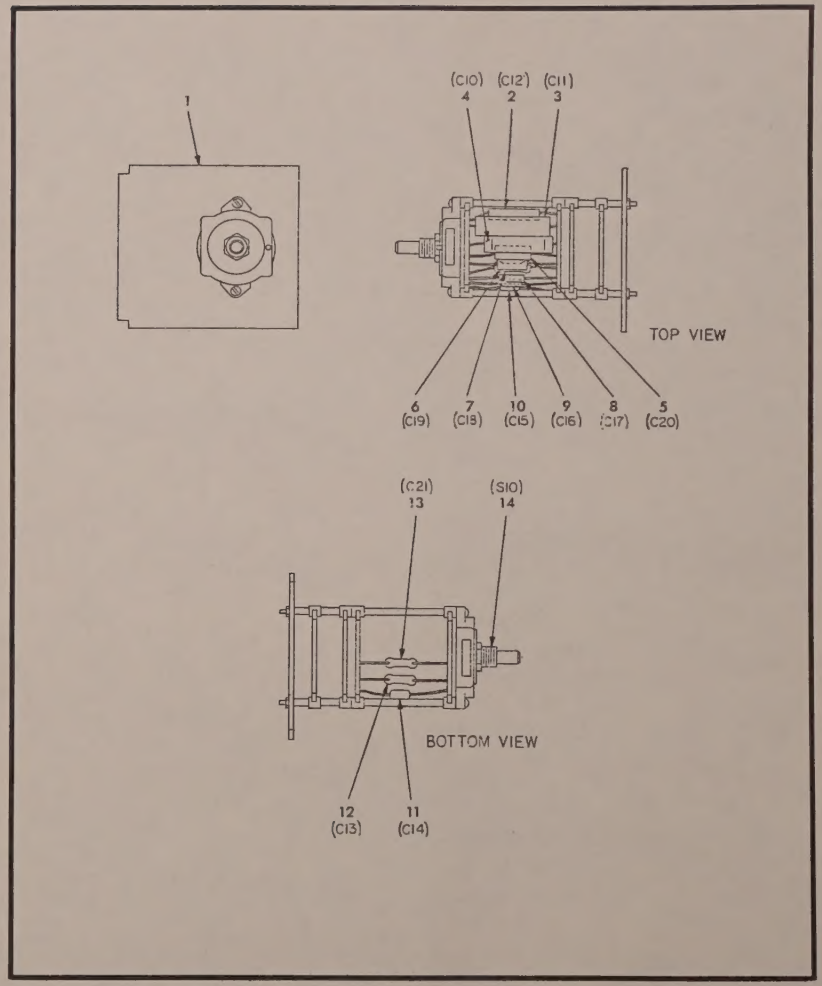


Figure 7-3. Model 6130A, Time/Div Switch Assembly, Exploded View